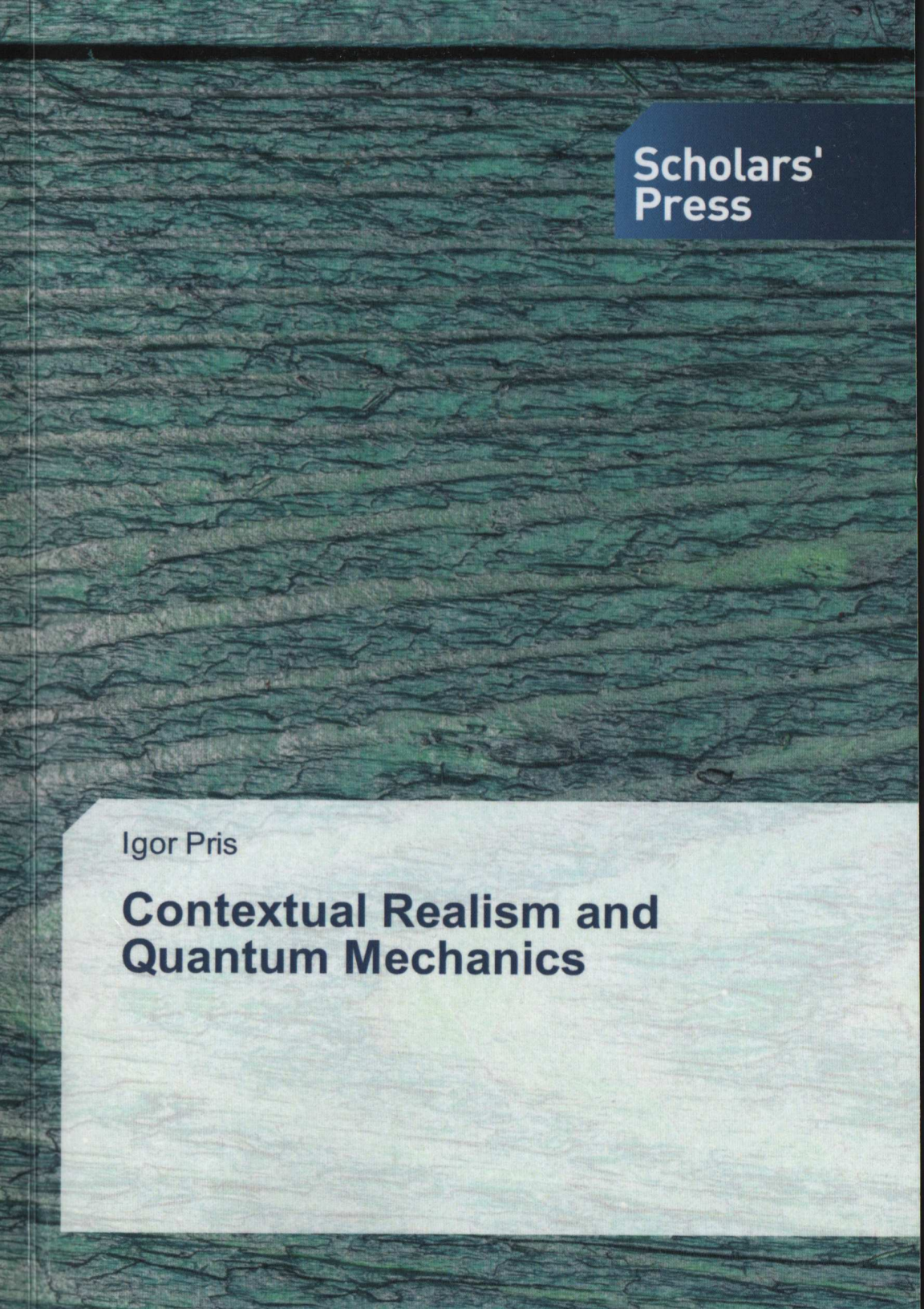




**Scholars'
Press**

Igor Pris

Contextual Realism and Quantum Mechanics

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Imprint

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This is a corrected, more readable rendering of the above English translation.

« *L'écart entre le factuel – le réel: ce qui n'est jamais que ce qu'il est – et la norme qui a vocation à le cerner, de façon correcte ou incorrecte, me paraît constituer une structure fondamentale de ce que j'appelle* (...) '*réalisme*'. »

(The gap between the factual and the real – that which is never anything but what it is – and the norm whose purpose is to grasp it, correctly or incorrectly, seems to me to constitute a fundamental structure of what I call (...) “realism.”)

— Jocelyn Benoist, *L'adresse du réel* (Paris: Vrin, 2017), p. 99.

« (...) *Un réalisme non plus de l'idéalité, mais de la règle, qui traite les instances réelles non plus comme des approximations de quoi que ce soit, mais comme des applications, correctes ou incorrectes, de la règle.* »

((...) A realism no longer of ideality but of the rule – one that treats real instances not as approximations of anything, but as applications, correct or incorrect, of the rule.)

— Jocelyn Benoist, *Réalismes anciens et nouveaux* (Paris: Vrin, 2018), p. 20.

We feel as if we had to penetrate phenomena: our investigation, however, is directed not towards phenomena, but, as one might say, towards the “possibilities” of phenomena. We remind ourselves, that is to say, of the kind of statement that we make about phenomena. (. . .) Our investigation is therefore a grammatical one. Such an investigation sheds light on our problem by clearing misunderstandings away. Misunderstandings concerning the use of words, caused, among other things, by certain analogies between the forms of expression in different regions of language. Some of them can be removed by substituting one form of expression for another; this may be called an “analysis” of our forms of expression, for the process is sometimes like one of taking a thing apart.

— Ludwig Wittgenstein, *Philosophical Investigations*, §90, trans. G. E. M. Anscombe, P. M. S. Hacker, and Joachim Schulte, 4th ed. (Wiley-Blackwell, 2009).

*The third manner in which progress can happen is how it does in philosophy: ideas are debated, absorbed, prove powerful, or weak, and slowly are retained or discarded. I am personally actually confident that this can happen for quantum theory. The key to this, in my opinion, is to fully accept this interference between the progress of fundamental physics and some major philosophical issues, like the question of realism, the nature of entities and relations, and the question of idealism. Accepting the reciprocal interference means in particular to reverse the way general philosophical stances color our preferences for interpretation. That is, rather than letting our philosophical orientation determine our reading of *QM*, be ready to let the discoveries of fundamental physics influence our philosophical orientations.*

— Carlo Rovelli, “Space is blue and birds fly through it,” *Philosophical Transactions A* 376 (2018): 20170312, arXiv:1712.02894.

A few more remarks of a general nature concerning concepts and [also] concerning the insinuation that a concept — for example that of the real — is something metaphysical (and therefore to be rejected). A basic conceptual distinction, which is a necessary prerequisite of scientific and pre-scientific thinking, is the distinction between “sense-impressions” (and the recollection of such) on the one hand and mere ideas on the other. There is no such thing as a conceptual definition of this distinction (aside from circular definitions, i.e., of such as make a hidden use of the object to be defined). Nor can it be maintained that at the base of this distinction there is a type of evidence, such as underlies, for example, the distinction between red and blue. Yet, one needs this distinction in order to be able to overcome solipsism. Solution: we shall make use of this distinction unconcerned with the reproach that, in doing so, we are guilty of the metaphysical “original sin.” We regard the distinction as a category which we use in order that we might the better find our way in the world of immediate sensations. The “sense” and the justification of this distinction lies simply in this achievement. But this is only a first step. We represent the sense-impressions as conditioned by an “objective” and by a “subjective” factor. For this conceptual distinction there also is no logical-philosophical justification. But if we reject it, we cannot escape solipsism. It is also the presupposition of every kind of physical thinking. Here too, the only justification lies in its usefulness. We are here concerned with “categories” or schemes of thought, the selection of which is, in principle, entirely open to us and whose qualification can only be judged by the degree to which its use contributes to making the totality of the contents of consciousness “intelligible.” The above mentioned “objective factor” is the totality of such concepts and conceptual relations as are thought of as independent of experience, viz., of perceptions. So long as we move within the thus programmatically fixed sphere of thought we are thinking physically. Insofar as physical thinking justifies itself, in the more than once indicated sense, by its ability to grasp experiences intellectually, we regard it as “knowledge of the real.”

— Albert Einstein, “Reply to Criticisms,” in *Albert Einstein: Philosopher-Scientist*, ed. P. A. Schilpp (Tudor Publishing Co., New York: Tudor Publishing Co., 1949), pp. 665–688.

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Foreword

According to the philosopher Hilary Putnam, any serious philosophical position, whether realist or anti-realist, must take into account “(. . .) the most fundamental physical theory we have, quantum mechanics” (Putnam 1990, Foreword, p. x). For his part, the physicist Carlo Rovelli argues that we should not interpret quantum mechanics according to a prior philosophical orientation, but should instead “allow the discoveries of fundamental physics to affect our philosophical orientations” (Rovelli 2018).

All interpretations of quantum mechanics can conventionally be divided into two classes: anti-realist (positivist, instrumentalist, neo-Kantian (Bitbol 2009), and others) and realist. With some reservations, the first class includes the Copenhagen interpretation (Bohr, Heisenberg, Pauli, and others), which treats quantum mechanics as a tool for describing and predicting quantum-mechanical phenomena; information-based interpretations (see, for example, Höhn 2014, 2018; Fuchs, “Quantum Mechanics as Quantum Information”¹); and QBism (Fuchs, “Notwithstanding Bohr. . .”; von Baeyer 2016).² The second class includes wave-function-collapse theories, hidden-variable theories (such as de Broglie–Bohm theory), and theories introducing many worlds and/or many minds (Bitbol 2000a). Everett’s original interpretation (Everett 1957) stands somewhat apart; it is usually classed among the realist interpretations. Carlo Rovelli’s relational interpretation of quantum mechanics, developed since 1996, is presented by him as realist in a weakened sense (though there exist neo-Kantian, empiricist, and structuralist readings of it as well): the quantum state and the values of physical quantities are real only *for* – relative to – an “observer” interacting with the observed physical system. The role of observer can be played by any physical system interacting with the observed quantum system (Rovelli 1996, 2016, 2018).

¹A survey of the main interpretations of quantum mechanics is given, for example, in Fuchs, “QBism: Quantum Theory as a Hero’s Handbook.”

²QBism is a Bayesian approach to quantum mechanics – a form of quantum Bayesianism, and one of the most recent interpretations of quantum mechanics. See the work of Christopher Fuchs, and also Mermin 2016 and von Baeyer 2016.

Rovelli’s interpretation is closely related to interpretations of quantum mechanics cast in the language of information theory. Connections can also be drawn to Michel Bitbol’s pragmatic, realist “modal (or participatory) substitution realism,” combined with quasi-realism, an approach we find more satisfactory than those above (Bitbol 2015). Our own interpretation is a Wittgensteinian one, developed within Jocelyn Benoist’s “contextual realism” (Pris 2018a, “Contextual Realism in Physics”); in many respects it is close to Bitbol’s (Bitbol 2015, 2019).³

Within our interpretation, any established and well-confirmed theory, quantum mechanics included, has its own domain of application, within which it is universal and, by its very nature, gives truth and knowledge. It is only in this tautological – or, better, logical – sense that one can speak of the universality of quantum mechanics. Outside its domain of application a theory is, strictly speaking, meaningless. In other words, an established theory acquires the logical status of a rule, or norm, for measuring reality, and as a consequence cannot, by definition, be falsified.⁴

Arbitrary hypotheses – that is, hypotheses not rooted in experience and practice, or belonging to other areas of knowledge – cannot affect the acceptance of a theory, nor can they refute an established one. As Newton put it: “In experimental philosophy, propositions gathered from phenomena by induction should be taken to be either exactly or very nearly true, notwithstanding any contrary hypotheses, until such time as other phenomena make these propositions more exact or liable to exceptions” (Newton 2012 [*Principia*, Rule IV]).

At first glance, the Ptolemaic system and Aristotelian mechanics might seem to be

³Some of our conclusions coincide with, or are close to, conclusions Bitbol reaches in Bitbol 2019, which we read only after the present work was substantially complete; our references to that book were accordingly added later. The difference between our positions is that Bitbol assigns a significant role to the neo-Kantian approach in a broad sense, whereas we proceed from a realist reading of the second and later Wittgenstein, together with the contextual realism inspired by Wittgenstein in the philosophy of Jocelyn Benoist, most of whose central claims we share (Benoist 2010–2019). From Benoist we take, as a founding point, the categorical distinction between the ideal and the real.

⁴This does not mean that it cannot be “falsified” from the standpoint of some more general theory – quantum field theory, for instance. In the same way, Einstein’s special theory of relativity and non-relativistic quantum mechanics “falsify” Newtonian mechanics, which, from their point of view, turns out to be an approximate or false (strictly speaking, meaningless) theory outside its own domain. At the same time, within its domain of applicability, Newtonian mechanics must still be regarded as true, both in the epistemic (empirical) and in the logical sense.

counterexamples: both were once well established and widely accepted, and both are now rejected. In fact, in Wittgensteinian terms, what happened is better described as a transformation of the “form of life.” Mathematically, the Ptolemaic system is not simply obsolete. As for Aristotelian mechanics, Carlo Rovelli has argued that it stands to Newtonian mechanics in the same relation in which Newtonian mechanics stands to Einstein’s theory: Einstein’s theory restricted the domain of Newtonian mechanics without refuting it, just as Newtonian mechanics restricted the domain of Aristotelian mechanics without refuting it (Rovelli 2013).

On our view, the applicability of any theory, quantum mechanics included, is context-dependent – both in a broad sense (a theory applies only within its domain of applicability, which is again a tautology) and in a narrow sense (any specific application of a theory within its domain requires attention to the concrete conditions – the context – of that application). The notion of a context presupposes that of a norm, implicit or explicit in the given context, and conversely: wherever there is a norm, there are its applications in context. As noted, a theory plays the role of a norm, or rule, rooted in reality. This is a rule in the sense of the later Wittgenstein; accordingly we speak of a *Wittgensteinian rule* (Pris 2008, 2012, 2014a, 2014b, 2015, 2018a, 2018b).

The problem of applying a norm, or rule, in context is the Wittgensteinian rule-following problem. This problem has the same structure as contextual realism. Among its instantiations are the measurement problem in quantum mechanics, the hard problem in the philosophy of consciousness, the incompleteness of mathematics established by Gödel, and others – between which there is, accordingly, a “family resemblance.” The gap between a rule (norm) and its application within a “form of life,” in a “language game,” is logical, not substantial: it is a gap between the category of the ideal, to which norms, rules, and concepts belong, and the category of the real, to which the application of norms, rules, and concepts belongs.⁵ The gap is closed from the outset whenever a rule is applied correctly – that is, within an authentic language game, one that is either established or subsequently justified (Pris 2008, 2012, 2014a, 2014b, 2015, 2018, 2018a, 2018b).

Our position agrees with Jocelyn Benoist’s realist stance:

« L'écart entre le factuel – le réel: ce qui n'est jamais que ce qu'il

⁵This categorical distinction between the ideal and the real, which traditional metaphysics ignores, we borrow from Jocelyn Benoist.

est – et la norme qui a vocation à le cerner, de façon correcte ou incorrecte, me paraît constituer une structure fondamentale de ce que j'appelle (...) 'réalisme'. » (The gap between the factual and the real – that which is never anything but what it is – and the norm whose purpose is to grasp it, correctly or incorrectly, seems to me to constitute a fundamental structure of what I call (...) “realism.”) (Benoist 2017: 99; Benoist, *L'adresse du réel*, Paris: Vrin, 2017.)

And again:

« (...) Un réalisme non plus de l'idéalité, mais de la règle, qui traite les instances réelles non plus comme des approximations de quoi que ce soit, mais comme des applications, correctes ou incorrectes, de la règle. » ((...) A realism no longer of ideality but of the rule – one that treats real instances not as approximations of anything, but as applications, correct or incorrect, of the rule.) (Benoist 2018: 20; Benoist, *Réalismes anciens et nouveaux*, Paris: Vrin, 2018.)

Introduction: The Main Problem of the Philosophy of Quantum Mechanics

The main problem in the philosophy of quantum mechanics is the measurement problem: the “process” of measurement is not described by the Schrödinger equation and requires separate treatment – in particular, one that clarifies the role of the quantum-mechanical observer and, with it, the nature and role of consciousness. The philosophy of quantum mechanics is thus bound up with the philosophy of consciousness (Bitbol 2000). Indeed, it turns out that the so-called “hard problem” in the philosophy of consciousness has the same structure as the measurement problem in quantum mechanics (Pris 2014b).⁶ Both problems, moreover, require a philosophy of language for their solution. The philosophy of the later Wittgenstein – which is perhaps less a philosophy of language than a philosophy of consciousness – makes it possible to treat both as pseudo-problems and thereby dissolve them (Pris 2018).⁷

Quantum mechanics is a non-classical theory, both physically and philosophically, which is why a satisfactory interpretation of it has proven so difficult to find. The study of consciousness likewise calls for unconventional scientific and philosophical approaches, and perhaps for broadening the very notion of an exact science; at the

⁶And conversely: it has also been proposed that quantum mechanics – a non-classical probability theory describing the phenomena of the microworld – might help explain consciousness, or at least uncover its physical basis. More recently, fields such as “quantum consciousness,” “quantum biology,” and “quantum neurophysics” have emerged and gained popularity. Roger Penrose and Stuart Hameroff, for example (Penrose 1989, 1994; Hameroff & Penrose 1996; Hameroff 2014), explain the emergence of consciousness through the laws of quantum physics. To account for neural processes in the brain, Matthew Fisher (Fisher 2015) proposed applying the quantum phenomenon of nuclear-spin entanglement. Others have tried to explain the unity of consciousness through the holistic character of quantum phenomena, in particular Bose–Einstein condensation (Marshall & Zohar 1990). According to Hameroff, quantum mathematics is an apt tool for studying cognition and decision-making. Understanding the relationship between quantum mechanics and consciousness will require further progress in quantum information theory and in the construction of quantum computers.

⁷See, for example, Benoist 2012, *Wittgenstein, philosophe de l'esprit*.

same time it demands conceptual analysis.

Francisco Varela, for example, as part of his neurophenomenological programme, proposes taking into account – alongside purely neurological data – stabilized phenomenal experience, thereby broadening neurological science (Varela 1996).⁸ Claude Romano, for his part, extends the concept of rationality by introducing a phenomenological rationality (Romano 2010). Jocelyn Benoist criticizes traditional phenomenology and proposes an “anti-phenomenology” (*das Gegenteil der Phänomenologie*), which does not reduce the given (*das Gegebene*) to givenness (*die Gegebenheit*) but instead restores the given (Benoist 2010a, *Le bruit du sensible*). Although Romano and Benoist take different approaches, both agree that traditional phenomenology needs to be recast in a realist way: phenomena are not autonomous, as traditional phenomenology held, but are rooted in reality.

At the same time, traditional metaphysical realism is not an adequate philosophy for understanding either modern physics or consciousness. Along with Hilary Putnam, Michel Bitbol, Jocelyn Benoist, and other philosophers, we reject it (Putnam 1990; Bitbol 2000–2019; Benoist 2010–2019). From the standpoint of quantum mechanics, there is no external, object-like reality to which its laws simply apply. Nor is consciousness an object of the same kind as the everyday objects, or the physical objects, around us. Metaphysical Platonism, which turns thought and consciousness into objects, leads to insoluble philosophical problems.

As for the Kantian approach, it disregards lived experience and phenomenal consciousness, denies the knowability of things in themselves, and relies on categories that are, in part, incompatible with quantum mechanics. As Heisenberg showed, for example, quantum mechanics rejects the Kantian category of causality; Schrödinger showed that it rejects the category of substance; and the so-called Einstein–Podolsky–Rosen (EPR) paradox shows that the category of interaction is likewise inapplicable. The Kantian a priori forms of sensible intuition – the Euclidean a priori of space and time – had already been overturned by Einstein’s general theory of relativity, even before quantum theory was complete. (As Einstein put it in 1924, it is no longer possible to hold on to “Kantian a priori concepts and norms.”)

⁸It has also been argued that quantum phenomena and the phenomena described by decision theory share a common relational structure (Zwirn 2009; Bussemeyer 2009; Bitbol 2019: 218). It has been shown, for instance, that the statistical distribution of the choices speakers make about the meaning of polysemous words, across different discursive contexts, coincides fully with the probabilistic predictions of quantum mechanics (Bitbol 2019: 218; Bruza 2009).

In contemporary theories of quantum gravity, space-time as a smooth manifold is not fundamental at all: it may be treated as emergent, or assigned a merely functional role, in a manner similar to functionalist approaches in the philosophy of consciousness. Alain Connes's noncommutative geometry unifies all interactions – gravitational and otherwise – algebraically, within a noncommutative space-time. As Bitbol notes, there are, in addition, three strategies for adapting transcendental epistemology to modern physics: (1) restricting its domain of application to ordinary knowledge; (2) seeking more general a priori principles that cover both the quantum and the relativistic domains; and (3) introducing the notion of a relative, historical a priori (Bitbol 2009). The concept of a relative a priori, dependent on the field of cognition, was introduced by Reichenbach (Reichenbach 1920, 1924); within his “practical realism,” Heisenberg likewise introduces a relative “practical a priori,” thereby transforming the Kantian notion of the synthetic a priori (Heisenberg 1958).

Michel Bitbol (Bitbol 2000–2015) holds that quantum mechanics is compatible with a neo-Kantian approach. He regards Niels Bohr's position as neo-Kantian in a broad sense, though he criticizes Bohr's principle of complementarity for mixing quantum and classical notions. At the same time, Bitbol assigns a significant role to the second Wittgenstein in interpreting modern physics and understanding consciousness.

In our view, the best philosophical approach to consciousness, to the interpretation of quantum mechanics, and to physical theory in general, is precisely the pragmatic Wittgensteinian approach in the broad sense – which is in fact a form of realism that overcomes traditional philosophical doctrines, neo-Kantianism included (Pris 2008–2015). This requires an unprejudiced reading of the philosophy of the later (and not only the later) Wittgenstein, too often interpreted as a linguistic idealism or relativism. One may also agree with Jocelyn Benoist that Wittgenstein, contrary to the usual assumption, is not a philosopher of language in the sense of one who emphasizes language for its own sake, but a philosopher of consciousness (Benoist 2012).

Unlike Bitbol, we hold that it makes sense to say that quantum mechanics describes a reality independent of the subject. In this we share Einstein's view: “Physics is an attempt conceptually to grasp reality as it is thought, independently of its being observed” (Einstein 1951: 81). The question, however, is what is to be understood by reality and by its observation (we will also use the expression “measurement of reality,” introduced by Benoist – see, e.g., Benoist 2017, *L'adresse du réel*). And what should be meant, specifically, by *quantum* reality?

We understand metaphysical realism as a position that is decontextualized – or, put differently, one that treats as substantial something that in fact belongs to the ideal, and is therefore not a substance at all. Platonism, which turns norms into substances, is one species of metaphysical realism: it mimics metaphysical object-realism about external reality, as though thereby explaining itself.

A non-metaphysical realist approach to consciousness and to quantum theory – one that accepts the existence of things independent of our consciousness, language, theories, and conceptual schemes – is, in fact, not merely possible but necessary. In our view, such an approach is to be found in the philosophy of the later Wittgenstein. Our position is close to Wittgenstein's in the broad sense given to it by Jocelyn Benoist, who develops a contextual realism built on a categorical distinction between the real and the ideal.

On thinking (and what Wittgenstein says here holds equally for consciousness in the broader sense):

Es ist nicht wahr, daß Denken eine Art Sprechen ist, wie ich einmal sagte. Der Begriff 'denken' ist vom Begriff 'sprechen' kategorisch verschieden. Aber natürlich ist das Denken keine Begleitung des Sprechens, noch sonst irgendeines Vorgangs. (It is not true, as I once said, that thinking is a kind of speaking. The concept "thinking" differs categorially from the concept "speaking." But of course thinking is not an accompaniment of speaking, or of any other process, either.) (Wittgenstein 1998, § 7.)

Benoist makes this more precise:

« (...) Penser n'est rien d'autre qu'une façon de construire une norme sur le monde même afin de déterminer ce qui est et ce qui n'est pas le cas. » (Thinking is nothing other than a way of constructing a norm bearing on the world itself, in order to determine what is and is not the case.) (Benoist 2012: 73.)

Thought, consciousness in the sense of "mind," meaning, concepts, and norms are all ideal: they are not substances in the image of real things. Real things acquire their identity only in context, through the application, or the fulfillment, of the relevant

norms (concepts) that allow them to be identified (in the case of natural objects) or realized (in the case of artifacts) (Pris 2018).

Philosophical problems in the study of consciousness and in quantum mechanics have much in common, since both are metaphysical problems that arise from turning norms into substances – from making them into (ideal) objects. This is why a philosophical analysis of quantum mechanics can be useful not only for arriving at a correct understanding of that theory, but also for understanding the nature of consciousness – and, conversely, why the philosophy of consciousness, and Wittgenstein’s therapeutic method in particular, can help resolve philosophical problems in quantum mechanics. (Similarly, Wittgenstein’s philosophy of mathematics helped him explore the nature of language, of psychological phenomena, and of consciousness – his paradigmatic examples of “forms of life,” after all, are mostly mathematical.)

The central problem in the philosophy of consciousness is that of understanding phenomenal consciousness – whether in physicalist or non-physicalist terms, e.g. by means of “phenomenal concepts” – the so-called “hard problem,” generally taken to be unsolved. There is said to be an ever-present “explanatory gap” between qualia – phenomenal qualities – and any explanation of them, not necessarily a physicalist one. Quantum mechanics, too, has been enlisted in attempts to close this gap. Analysis shows, however, that a purely reductive explanation of consciousness within physical theory, one that does not appeal to phenomenal experience, is impossible.

In fact, it is precisely the neglect of the categorical distinction between the conceptual – which is ideal – and the real – for instance, phenomenal experience – that generates the pseudo-problem of the explanatory gap. We can never literally compare the ideal with the real, as though they were two substances, in the substantive sense of “explaining” the real by means of the ideal. In fact the “explanatory gap” is closed from the outset, in the correct application of the relevant (physicalist or phenomenal) concept. The very existence of such a concept presupposes paradigmatic cases of its use, cases developed out of experience rather than detached from it. Hence a physicalist concept whose use is not ultimately tied to phenomenal experience cannot pick out phenomenal experience. In this sense phenomenal experience is irreducible – though this does not mean that it is unreal, or somehow outside nature.

Put differently, the problem arises from treating the ideal (a description or concept of experience) and the real (phenomenal experience or consciousness itself) as opposites belonging to one and the same category. The gap between them is then treated as substantial, and consequently as unbridgeable – since it is indeed impossible to

bridge a substantial gap between the ideal and the real, to turn what belongs to the category of the ideal into what belongs to the category of the real. In fact, the “gap” is a logical gap between a phenomenal concept and its application, one that concerns the conditions under which the concept is applied. Closing it calls for an understanding of the nature of concepts and their conditions of application, not for some positive metaphysical solution.

A phenomenal concept – a concept that picks out phenomenal experience – is by definition developed in practice, through its application to phenomenal experience; and, by definition, within the language game of its correct application, the gap between the concept and the experience is already closed. In other words, the so-called explanatory gap is closed “pragmatically,” and the explanatory-gap problem is a pseudo-problem.⁹

As for the nature of phenomenal experience: inasmuch as it is real (the phenomenal concept is developed and applied within reality), one can say that it has physical properties in a broad sense – but is not *physical* in the narrower sense of being fully describable by purely physicalist concepts. Purely physicalist concepts simply do not apply to phenomenal experience.

The problem of finding a satisfactory interpretation of quantum mechanics, which has beset the theory since its inception, is likewise considered unresolved. The central difficulty is the “measurement problem”: the so-called reduction of the wave function describing the state of a quantum system is not governed by the Schrödinger equation but is simply postulated, in order to account for the observed values of physical quantities. At bottom this is the problem of explaining the transition from the potential to the actual – from the potential outcomes of a measurement to the single, specific result observed in experience.

Some physicists and philosophers try to solve the measurement problem metaphysically, by adding consciousness to the formalism of quantum mechanics as something external to it. Wigner, for example, holds that consciousness affects the physical world (Wigner 1979); Mensky proposes incorporating consciousness into the theoretical description of the quantum observer (Mensky 2005); and Stapp, drawing on Whitehead, develops an ontology of “occasions of experience” as spontaneous quantum-mechanical events of wave-function reduction, which he takes to have a

⁹It seems to us that our anti-reductionist view of consciousness, and our dissolution of the “hard problem,” is close to the positions of Jocelyn Benoist and Michel Bitbol (Benoist 2012, 2017; Bitbol 2000–2015).

dual nature, at once conscious and physical – consciousness does not explain the actualization of a given physical reality but is bound up with it (Stapp 1993; Bitbol 2000: 49; see also the survey of further positions in Bitbol 2000). The subjectivist, dualist approach to interpreting quantum mechanics is, in our view, a departure from science.

Since what is really at issue is the actualization of a potential, it is natural to turn instead to a pragmatic approach – one attentive to what physicists actually do, to how they apply the theory (Pris 2008; Bächtold 2009; Bitbol 1996–2018). A pragmatic approach goes hand in hand with Wittgensteinian therapy: what is needed, first of all, is to lay bare the logic of the concepts in use. This requires deploying the correct concept of reality and clarifying the nature of concepts and of the relation between concepts and reality. In other words, what is called for is primarily a therapeutic analysis of the problem, rather than a metaphysical solution to it; ontological considerations remain legitimate, but are secondary, and their applicability has limits.

It follows that the “hard problem” of consciousness and the “measurement problem” of quantum mechanics share the same structure. As noted above, the “hard problem,” properly stated, is the problem of understanding subjective (phenomenal) experience: there is a “gap” between a phenomenal concept (or a description of experience) and reality – phenomenal experience itself. (Phenomenal experience as such has no conceptual structure; it is simply something perceived – a perception – between which and reality there is no distance.) The solution, or rather the dissolution, of the problem is that the “gap” is logical, not substantial: it is closed from the outset, as part of the “language game” of applying a phenomenal concept. This is an instance of the Wittgensteinian rule-following problem, where the role of the rule is played by the phenomenal concept used to “measure” reality. A given type of phenomenal experience, or a particular phenomenal experience, can be identified by means of the corresponding phenomenal concept, whose application presupposes the availability of paradigmatic phenomenal experiences – which is precisely what rules out a purely reductive physicalist approach to consciousness.

In the same way, the measurement problem in quantum mechanics admits a pragmatic solution in terms of the Wittgensteinian rule-following problem: quantum mechanics is not a literal representation (“reflection”) of reality, but plays the role of a norm for measuring reality, for identifying or realizing quantum phenomena. The “gap” between it and reality is logical. The application of a norm, the use of a rule, is a “language game” in which a quantum phenomenon – something quite concrete and tangible – is identified, or realized, within the quantum-mechanical context of

measurement. The phenomenon of quantum correlation between the measurement outcomes obtained on a system composed of two interacting, and hence entangled, subsystems, for example, is identified (realized) only by means of quantum theory: there is no further, “deeper” explanation of the correlation in terms of hidden variables.

More generally, we interpret any physical theory as a “Wittgensteinian rule,” not in an instrumentalist sense but in a realist one: it is a “rule” that is developed, and rooted, in reality, in its paradigmatic applications. If quantum mechanics was at first regarded as a peculiar, “non-classical” theory, it now turns out, in retrospect, to be a paradigm for scientific theory as such: from a philosophical point of view, even classical theories can be seen as rules for measuring reality. Put differently, any true theory has a pragmatic dimension – it bears on action, rather than merely “reflecting” an “independent” reality.

On this view the role of consciousness becomes clear. “Consciousness” in the sense of the sensible – unconceptualized perception – is not a representation of reality but reality itself (on Jocelyn Benoist’s view, there is no distance between perception and reality; Benoist 2011). In this sense it helps close the gap between a theory and its application: the theory applies to reality, and its paradigmatic applications therefore include perceptual experience. (Consciousness *as a norm* – as a concept for identifying the subjective, phenomenal included – is, by contrast, ideal, just as theory is; such consciousness might be called “mind.”)

It should not be forgotten, however, that the pragmatic “act” of applying a theory is not itself a substantial act. The logical “gap” between the conceptual and the real is closed from the outset, within the relevant language game of applying the concept – whether in identifying phenomenal experience or in measuring a physical quantity. In other words, the pragmatism at issue here is a *normative* pragmatism: the pragmatism of language games governed by norms/rules. It is within the language game that the gap in question is closed.

Normative pragmatism has been developed by Robert Brandom (Brandom 2011). Brandom holds that the later Wittgenstein is a normative pragmatist and naturalist; his own approach, however, has in our view its shortcomings – in particular, Brandom neglects the study of first-person phenomenal experience. (Timothy Williamson, too, has criticized Brandom’s inferentialist semantics; Brandom 2000.) As noted above, we are closer to Jocelyn Benoist’s approach: a Wittgensteinian “contextual,” or “normative,” realism, on which being – whether purely physical (physical phenom-

ena, objects, structures) or experiential (consciousness) – is contextual throughout. Deontologizing a metaphysically decontextualized ontology helps to resolve the problem of qualia and of measurement alike.

In particular, the neo-Kantian interpretation of quantum theory proposed by Michel Bitbol can, in our view, be improved precisely by being recast in terms of contextual realism. Bitbol’s categorical distinction between norms and reality corresponds to the “balance” that, within quantum mechanics, is struck between real “events” – understood by him in a deontologized sense – and “theoretical entities.”

The pragmatic, contextualist approach we propose requires an understanding of modality – relevance, possibility, necessity (Pris 2014, “Illusions. . .”; Benoist 2017). See also Brandom’s treatment of modality and counterfactuals as part of his normative pragmatism (Brandom 2008). We treat modalities within our interpretation of the second Wittgenstein (Pris 2008, 2015): for us, real possibility is the possible application of a Wittgensteinian norm, such as a physical theory (Pris 2008). Possibilities are thus real, but not in the sense of David Lewis’s modal realism; their reality is to be understood, within contextual realism, as the real possibility of applying a norm, and the real possibility of transforming the norm itself (Benoist 2017).

Michel Bitbol, for his part, proposes a pragmatic, modal interpretation of the axioms of quantum mechanics within a “modal substitution realism” – a realism about possibilities – in place of an ontological realism of material bodies (Bitbol 2015). This approach is closely related to our Wittgensteinian one and can be recast, and modified, in terms of contextual realism. In particular, as part of his approach, Bitbol proposes replacing the concept of a thing with that of an event, which he deontologizes; we retain both concepts. Indeed, we agree with Bitbol that any theory whatever, not only quantum mechanics, carries pragmatic and modal meaning.

The logic of the concept of possibility – and hence the relation between possibility and probability – can be grounded in the experience of particular possibilities. Bitbol, for instance, appeals to the “experience of possibles,” to “irreversibility,” and to the “mutual unavailability” of possibilities (Bitbol 2015). This approach connects with phenomenological analyses of the concept of the possible (e.g. in Husserl) and of the event (e.g. in Claude Romano 1999).

The process by which experience becomes conceptualized and stabilized – that is, the emergence of perceived (conceptualized) quantum reality on the basis of theory – is secondary. Quantum mechanics, like any true theory, presupposes such a domain

of stabilized (conceptualized) experience; likewise, as noted above, understanding consciousness through phenomenal concepts presupposes a stabilized, paradigmatic phenomenal experience. That is: objects in the broad sense (not only visual objects but experience itself), their properties, the relations among them, and the “laws of nature” that govern them, are all secondary – they are formed within reality, on the basis of reality. This is how the Wittgensteinian “form of life,” and the corresponding ontology, comes to be formed.

A correct understanding of modality shows that “many-worlds” interpretations of quantum mechanics are mistaken. In particular, the metaphysical reading of Everett’s approach – one that introduces parallel worlds and a splitting of the observer’s consciousness – is untenable. We fully agree with Jocelyn Benoist that this kind of interpretation of quantum mechanics amounts to bad – that is, rule-less – “baroque physics.” We have elsewhere proposed a Wittgensteinian demystification of the metaphysical interpretation of Everett (Pris 2016, “A Wittgensteinian Demystification of the Everett Interpretation”). Bitbol, working from his own pragmatic, modal critique of the metaphysical reading of Everett, reaches a similar conclusion (Bitbol 2015).

The concept of possibility is bound up with the concept of the event, the study of which affords a better understanding of the nature of time and, through it, of consciousness. Bitbol, for instance, uncovers a “logic of time” by deontologizing the event,¹⁰ interpreting the irreversibility of time as logical rather than metaphysical in nature – an approach that echoes Jocelyn Benoist’s. Both philosophers likewise criticize the representationalism and the subject/object dualism of modern epistemology, though one argues from an analysis of physical theory and the other from a critique of phenomenology and of the notion of reality.

Studying the foundations of quantum mechanics and the nature of consciousness within the framework of contextual realism makes it possible to understand the source of the difficulties facing traditional epistemology. Among the mistaken doctrines that need correcting are the problem of access to reality, metaphysical representationalism, subject/object dualism, metaphysical epistemic realism, correlationism, and other such positions.

¹⁰The connection between philosophical and mathematical approaches to time can be illustrated by the treatment of time proposed by Alain Connes and Carlo Rovelli within thermal-time theories of quantum gravity, cast in terms of von Neumann algebras. On this approach the emergence of time is tied to the noncommutativity of space-time observables (Connes 1994; see also Rovelli 2011).

Contextual Realism

As a primary, fundamental concept we choose the notion of reality. By definition, reality is what it is (Benoist 2014). This is a categorical definition: it fixes the logical status of reality, not its properties. There is nothing positive to be said about reality as such, and no point in constructing a theory of reality as such. It is possible, however, to study particular types or regions of reality in a substantive way. Everyday reality (tables, trees, houses), physical reality (quarks, electrons, atoms, galaxies), mathematical reality (numbers, axioms, theorems), social reality (states, legal systems, social statuses), and so on, differ in nature; nevertheless they are all real in the very same sense fixed by the concept of reality.

The concept of reality is enriched by the historical development of humanity and by the emergence of new types of reality – quantum physics adjusts our understanding of reality, new types of social reality continue to come to light (Maurizio Ferraris, for example, introduces an “ontology of documents”; Ferraris 2014, 2015; some philosophers speak of an “informational” reality; and so on) – but the concept of reality itself cannot change in any foreseeable sense. As we have said, reality is simply what it is, and we are always brought up short against an everyday reality that will not go away. If the concept of “reality” could be freely altered or redefined at will, it would no longer be a true concept of reality at all. A true concept of reality must be rooted in reality itself, not introduced by theoretical fiat – and we need such a concept: in order really to deal with reality, to act in the real world (and to act only in the real world), we need a true concept of reality, one that does not lead us into an illusory world, does not paralyze our actions, and does not encourage conformism or the acceptance of an actual state of affairs that in fact calls for change (this holds with particular force for social reality). Realism implies an engaged subject.

The metaphysical representation of a (pre)given reality of the “outer world,” for example, dogmatically fixes this or that identity of things, properties, and relations. Ascribing so-called intentional objects (a red cap, a unicorn, an imaginary friend, a golden mountain, and so on) to the status of real objects – as Markus Gabriel does, for instance – creates an imaginary barrier between the subject and reality, one that

prevents the subject from acting on, and coming to know, reality (Gabriel 2015). The Platonic hypostatization of norms leads to the idea of an immanent imperfection and secondary status of the things of this world, of an ideal (true reality) that is never attainable. The phenomenological notion of autonomous phenomena that reveal themselves purely from themselves likewise draws us away from reality, into the sphere of mere appearance and, ultimately, into the sphere of pure subjectivity (Benoist 2016, *Logique du phénomène*).

The concept of reality carries with it a sense of reality that, according to some postmodernists, has been lost. This sense is formed above all in everyday experience, in practice; perception, and above all visual perception, plays a foundational role in its formation. What we perceive in everyday life through our senses, under normal conditions, is real. This claim is primarily semantic – one could also say analytic, or logical: it belongs to the very definition of what we call “the real” and “reality.” Scepticism is accordingly false: a sceptical question (a doubt) is meaningful only if there are, in fact, specific grounds for raising it.

It follows from this that the understanding of perception plays a foundational role in understanding the concept of reality. We distinguish between intentional and non-intentional components of perception (some philosophers hold that perception is always intentional; we reject this view). To denote the non-intentional component of perception – one between which and reality there is no distance – we introduce the technical term *the Perceptible*.¹¹ The Perceptible is reality itself; it belongs to the category of the real. It is what it is. Figuratively speaking, the Perceptible is the point of contact between the outer world (what is perceived – the object) and the inner world (perceiving); more precisely, it is the point at which reality divides into an outer and an inner world, both of which are secondary to the notion of reality – that is, to the Perceptible. The subjective and objective worlds, ontology, intentional perceptual experience, are all secondary: the latter is, so to speak, a normalized, non-intentional perceptual experience, whose normality just is its intentionality – norm is intentionality. This norm-intention develops, in reality, out of non-intentional experience; it is not imposed from outside. It therefore depends on context (on specific circumstances), and is itself applied in context, correctly or incorrectly. When a norm-intention is applied correctly it is said to be “fulfilled” (following Jocelyn Benoist, and consistent with our own view, we interpret Edmund Husserl’s concept of “fulfilled intention” as the correct application of a norm; Benoist 2007). The contextual realism at issue here can accordingly also be called “intentional

¹¹We translate the French term *le sensible* as “the Perceptible,” and interpret the corresponding concept as it has been explored by Jocelyn Benoist (Benoist 2013).

realism,” or “normative realism” (Benoist 2011).

These are not metaphysical intentional or normative realisms, but contextual ones. Norm-intentions do not exist (are not real) in themselves; they have no autonomy, and are not literally naturalized as part of natural reality. In themselves they belong to the category of the ideal, as distinct from the category of the real. They are real only in the sense that they are rooted in reality – that is, they have real conditions of existence and application. Being rooted in reality means satisfying two conditions: appropriateness and correctness. The first means that a norm has a domain of applicability to which it must conform (an established physical theory, which we interpret as a Wittgensteinian norm or rule, is true, for example, just in case it conforms to its domain of applicability). The second means that the application of the norm within its domain is itself correct. The satisfaction of the second condition obviously presupposes that of the first.

It should be noted that we will often use the terms “norm,” “rule,” and “concept” interchangeably; accordingly, we may also speak of contextual “conceptual” or “semantic” realism – again, not in a metaphysical sense. The conditions of appropriateness and correctness apply equally to concepts and meanings taken as true. Pseudo-concepts and pseudo-meanings are detached from reality; true concepts and true meanings are developed within reality and are nourished by it – reality is their ground. The idea of autonomous meanings, meanings as, so to speak, “a state within a state” (Jocelyn Benoist’s phrase), was widespread in analytic philosophy of the second half of the twentieth century. Such a metaphysical “semantic realism” is, in fact, a semantic idealism.

The emphasis in the phrases “contextual realism,” (contextual) “normative realism,” (contextual) “intentional realism,” (contextual) “semantic realism,” (contextual) “conceptual realism,” and so on, can shift from one word to another; we are speaking throughout of two inseparable aspects of one and the same contextual realism. A real thing can be given only from within a certain point of view, description, intention (understood as a mode of description), or application of a concept, norm, or theory – one that does not create the thing but identifies it (a thing does not exist merely because of a conceptual scheme; otherwise the position would collapse into idealism). Our realism is thus intentional, normative, conceptual, semantic, and contextual all at once: things acquire their identity only in context. At the same time, conversely, the intention, norm, theory, point of view, conceptual scheme, or meaning through which a thing is given is itself internal to this or that context, and is itself rooted in reality; in a certain – non-categorical – sense, it too is real. That is, our intentional (normative,

and so on) realism is also, in this derivative sense, a realism *about* intentionality, norms, and so on. We will accordingly also speak of the reality of context, or of context as reality itself. Context is something presupposed; it cannot itself be defined – were it definable, it would not be context but a determinate object. Within contextual realism, all real objects are rooted in context-as-reality, which is what allows them to vary in identity depending on the context. As Jocelyn Benoist observes, contextuality is a fundamental epistemological and ontological property of reality: what lacks this property is not real.

Later on we will extend the notion of the perceptual experience of the Perceptible to further, more remote regions of reality, so that we will also speak of the Perceptible in physics (we can, for example, “feel” a fragment of the reality of subatomic particles), in mathematics, in the social sphere, and so on.

We ourselves are part of everyday, physical, social, and other kinds of reality. As such, these are not, in themselves, conceptualized: we obtain “access” to them only once we have developed, and mastered, the relevant concepts – that is, once we are able to apply them correctly. Physical reality as such is an unconceptualized physical Perceptible. This physical Perceptible is not, however, always and to just anyone “given” – not in the sense of a given (determinate) object, i.e. something already possessing an identity, but in the sense of a “given,” unconceptualized (indeterminate) fragment of physical reality (though the very fact that we can speak of *physical* reality already presupposes a certain minimal conceptualization by means of physical concepts). A fragment of reality is not simply given to us the way a phenomenon or an object is; it can be “given” to us, or not, only in the sense that we can come into contact with it, or fail to. This “givenness” is a necessary condition for its subsequent conceptualization in a given context. Let us stress once more that the conceptualization in question is not an arbitrary imposition of identity on a fragment of reality from outside, but the identification, within that fragment, of an object (an identity) that is genuinely there, in this or that context. Our position is contextual realism, not idealism.

In order to come into contact with some fragment of reality, it is necessary to have already outlined it conceptually to some degree: every fragment of reality presupposes some minimal degree of conceptualization. In Wittgensteinian terms, not only the existence of determinate objects but the Perceptible itself presupposes some “form of life.” Paradigmatic (real, reality-rooted, and hence “perceptible”) objects are identified within a form of life, as are new, not-predetermined objects – things that, prior to their identification, though real, had no identity. The identification

of a new object is preceded by a “datum” that is not the datum of the object but simply the presence of a fragment of the Perceptible (though, as noted, some minimal conceptualization is already at work in this presence of an outlined fragment of reality), with which the subject comes into contact within a given form of life. Let us give a few examples.

The identification of the Higgs boson as a real object (an “elementary particle”), as the result of applying a theory, of numerous experiments, and of statistical processing of the experimental data, was preceded by a certain physical Perceptible – the study of a fragment of reality within the framework of the Standard Model, together with the practice of applying it, which together played the role of a physical form of life. Outside that form of life, not only could the Higgs boson not be given, or “discovered,” but the corresponding fragment of reality – the physical Perceptible in which the boson was found – could not be “given” at all. The Higgs boson was not simply designed by theory and experience taken together – that is, experience does not carry a “theoretical load” in that crude sense – nor was it “discovered” in a metaphysical sense, as though it were some pre-existing object of an outer world. Rather, it was *identified*, as described above: as a result of the practical application of the theory in context, it acquired an identity.

The tau neutrino, likewise, was not discovered “all at once,” and the concept “tau neutrino” was not defined in a single stroke. It formed gradually, both theoretically and experimentally: a fragment of reality was progressively outlined and clarified, within which a tau neutrino was eventually identified and then, finally, established (“discovered”). Briefly, the history runs as follows (Blondel 2019): the concept, and the corresponding symbol, of a “tau neutrino” was introduced in 1977. That a neutral particle – a neutrino – is present in tau decay was established in 1979. That the tau particle is accompanied by a third neutrino, the tau neutrino, as the isospin partner of the tau lepton, was finally established between 1981 and 1986. The properties of this particle were precisely determined in 1989, in electron–positron and proton–antiproton collision experiments. The interaction of the tau neutrino with matter was directly observed in 2000 (Blondel 2019).

Let us turn to an even earlier episode in the history of physics. Einstein and Infeld write:

In the beginning, the field concept was no more than a means of facilitating the understanding of phenomena from the mechanical point of view (. . .). Gradually the acceptance of the new concepts progressed,

until the field concept overshadowed the concept of substance. It was realized that something of great importance had happened in physics. A new reality was created, a new concept for which there was no place in the mechanical description. Slowly and by struggle the field concept established for itself a leading place in physics and has remained one of the basic physical concepts. The electromagnetic field is, for modern physics, as real as the chair on which we sit. (Einstein and Infeld 1938: 157–158.)

This transformation of concepts into full-blooded concepts identifying new, well-defined physical realities is an ongoing process. It is well known, for example, that Heisenberg did not believe that thought experiments involving single atoms could ever be realized in practice; nevertheless, they have since become reality (see, e.g., Haroche 2006, 2007). Likewise the concepts of black hole, Higgs boson, gravitational wave, and others, have become reality. (On the history of the concept and the discovery of the Higgs boson, see, e.g., Iliopoulos 2013.)

Thus a physicist may find himself dealing with an unconceptualized fragment of physical reality – one for which he does not yet have the requisite theory. In just the same way, one can be dealing with a fragment of social reality as such – an unconceptualized social Perceptible. In the absence of the relevant concepts and theories, social phenomena can be perceived as a social Perceptible, as bare social reality in its own right. We can, for instance, perceive the “yellow vests” protest movement in France without yet understanding it, without yet knowing how to conceptualize it correctly – that is, to identify its genuine aspects, rather than arbitrarily imposing an identity on it from outside. Is this movement a revolution? What are its real causes, and its possible consequences? Is there any kinship between it and the protest movements in Venezuela, or the so-called “colour revolutions” in the post-Soviet space? And so on. This or that fragment of social reality (a social Perceptible) is accessible to us, initially, so to speak, in “raw” form – not yet in the form of determinate social objects, phenomena, or essences – only within this or that social form of life. If we know nothing about revolutions, we cannot even properly raise the question of whether the “yellow vests” protest is one. Conceptualization begins where we pose a question and seek an answer, as a result of trying to answer questions that interest and matter to us.¹²

¹²For Heidegger, we do not simply hear a beep, or a car horn: we directly (not indirectly) hear the horn of the postman’s van – that is, we perceive it directly in its social dimension. This dimension could of course be missed, say by someone unfamiliar with how mail is delivered,

The contextual perspective can be brought to bear on any domain of inquiry in which the question of reality arises. In particular, it seems to us that the reality of the past is likewise contextual. As Barreau writes:

« nous ne sommes pas responsables de ce qui s'est fait autrefois sans que nous puissions intervenir. Mais nous sommes responsables de ce que nous pouvons rendre présent et introduire dans l'existence. Les Stoïciens avaient bien compris cela. Ce sur quoi nous ne pouvons strictement rien ne doit pas nous inquiéter, même s'il doit requérir notre attention. Pour la nature il n'en est pas fondamentalement autrement. Niels Bohr a repris, en l'appliquant au devenir naturel qu'étudie en particulier la mécanique quantique, la formule de Kierkegaard: 'Nous sommes acteurs, et pas seulement spectateurs, dans le grand drame de l'Univers.' »

(We are not responsible for what happened in the past without our being able to intervene in it. But we are responsible for what we can make present and bring into existence. The Stoics understood this well. What is strictly beyond our power should not trouble us, even if it must command our attention. And matters stand no differently with respect to nature. Niels Bohr took up, and applied to the natural becoming that quantum mechanics in particular studies, Kierkegaard's formula: "We are actors, and not merely spectators, in the great drama of the Universe.") (Barreau 1988: 13.)

Wheeler writes (quoted in French translation from Bitbol 2019: 261):

"The past" is theory. The past has no existence except as it is recorded in the present. By deciding what questions our quantum registering equipment shall put in the present we have an undeniable choice in what we have the right to say about the past. (Wheeler, quoted in Bitbol 2019: 261.)

a foreigner, or a child. In such a case the social meaning would not be conceptualized as the postman's horn, as a signal of mail delivery, but it would not thereby cease to exist. Wittgenstein calls a person unable to identify certain aspects of reality, for want of the relevant concepts, "conceptually blind."

This or that piece of reality is what it is – it has, so to speak, itself; but it has no identity unless it is conceptualized, and conceptualization is possible only within this or that context. Conceptualization is not an external, so to speak violent, act; it is, figuratively speaking, a movement within reality itself.

Depending on the context, “the same” fragment of reality may acquire different identities. Depending on the concepts (norms, rules) applied to it – and the choice of which concepts to apply itself depends on context, as does their application – it can change its identity. This does not mean that identity is imposed from outside; quite the reverse: concepts (norms, rules), in context, identify, within a fragment of reality, an object whose identity thereby depends on context. The identity of a real thing is not fixed once and for all. It is precisely the unlimited contextual variability of identity that allows us to say that something is real. In Jocelyn Benoist’s words – let us repeat this once more – contextuality is the fundamental epistemic and ontological property of reality (Benoist 2017).

Objects, then, arise in context, as the result of applying concepts. Together with those concepts, they are rooted in reality, are nourished by it, and can change their identity when placed in a different context. Real objects are tangible objects, things themselves – what exists. Reality itself is not an object; it does not exist in the sense in which objects exist. It simply is. In other words, reality is primary, and ontology is secondary and contextual.

Whatever is not real falls under the ideal. Concepts, norms, rules, meaning, language as the paradigm of any normativity – all these we classify as ideal. The ideal is not located in some ideal Platonic realm; it is not a substance to which there is some special contemplative, intellectual access. It makes no sense to set the ideal and the real “over against” one another, to compare them, as though they belonged to a common category, or super-category. The ideal is “movement” within reality: it occurs when we do something with reality, practically or theoretically (cognition, too, is an activity). Concepts arise, in particular, wherever differences arise, wherever things can be compared, identified, described, explained, and so forth – but concepts are not, in themselves, some special kind of reality (an “ideal” reality).

Reality as such is meaningless – not in the sense that we have lost, or failed to find, its meaning, nor in the sense that it might have had a meaning but does not, but in the sense that it makes no sense to speak of its meaning at all. Reality and meaning belong to different categories. Reality as such has no fixed conceptual structure, no normative dimension; concepts, norms, meanings (semantics), knowledge (epistemology) are

secondary, and are developed within reality – it is our task to develop and apply them. Ontology, too, is secondary to reality, since what exists is precisely what is identified by concepts (norms) in context: ontology is context-sensitive. There is, however, no point in saying that reality *itself* is context-sensitive. In a sense one can say that context is reality itself, since to be rooted in reality just is to be rooted in context.

Reality as such (the Perceptible as such) is silent, yet it is not merely silent: on the contrary, meaning as such is silent too, though not merely silent. Beneath ideal meaning lies the reality that nourishes it and in which it is rooted (were it not so, we would have a pseudo-meaning – a meaning autonomous unto itself). The silent murmur of the Perceptible precedes meaning and is a condition of its existence. One can speak of the reality of (genuine) meaning only in the sense of its being rooted in reality – in the sense that there exist real, though never exhaustively specifiable, conditions for that meaning. As said above, contextual semantic realism can be understood precisely as meaning rooted in reality, not as meaning's autonomy. Let us repeat once more that the stress can fall on either word, “realism” or “semantic”: we are speaking of two aspects of one and the same contextual position. It is semantic realism because what (really) exists is given, is assumed, in a semantic perspective, a meaning; and it is semantic realism because that meaning, that semantic perspective, is in turn rooted in reality (without being real in itself).

The subject who develops meaning is itself formed as a result of this same process and, more broadly, of a process of evolution – not merely natural evolution, but conceptual, normative, and linguistic evolution as well. Together with norms, concepts, language, and consciousness, the subject emerges within, and out of, reality; it is rooted in reality, and is not the autonomous, modernist subjectivity that twentieth-century phenomenology absolutized – a phenomenology which, in trying to rid itself of the subject, transformed the concept of the phenomenon into an extremely subjectivist one.

We are not outside reality; we are part of it, constantly interacting with it. There is therefore no problem of the subject's “access” to reality, as modern (and postmodern, which generally rejected the very notion of reality) philosophy supposed. Modern philosophy privileged epistemology: the subject was placed outside the reality it comes to know, and knows it only through representation. Modernist representation-alism holds that there is a mediator between us and reality – a (mental) representation; language, too, plays this role in much twentieth-century philosophy. Representation thus functioned as a kind of veil that had to be lifted in order to gain “access” to reality. Postmodernism went further still, and questioned whether anything exists

behind this “veil” at all – effectively identifying our perceptions with reality itself.

In fact, as we have said, we are part of reality, originally in contact with it; a standpoint from outside reality is impossible. We are always situated within a certain “form of life,” which is nothing but a set of language games obeying one and the same rule – the “grammar” of that form of life, which establishes family resemblances among its language games. Our form of life can also be called the domain of “everyday meaning,” in both the narrow and the broad sense: the domain of ordinary opinion, knowledge, and the obvious. We accept Timothy Williamson’s position that the obvious (in context) just is knowledge (in context): obviousness equals knowledge. This holds for both science and philosophy. According to Williamson, philosophy is a systematic, theoretical, and critical inquiry grounded in reasoning together with the obvious (Williamson 2019), and is thus a full-fledged science. Obviousness is never absolute – as logical empiricists supposed, for instance, when they identified it with the obviousness of immediate sense-data, or as phenomenologists supposed, when they took the phenomenon to be self-evident. Mistakes are possible, but they can also be corrected. Scepticism is rejected.

Contextual Realism in Wittgensteinian Terms

Jocelyn Benoist, in developing his version of contextual realism, draws on the ideas of Ludwig Wittgenstein, John Austin, and Charles Travis. The last of these is a radical contextualist who counts himself a follower of Wittgenstein. Some philosophers reject Travis's radical contextualism, and likewise deny that the term "contextualism" properly applies to the later Wittgenstein's philosophy. On our view, Wittgenstein can be called a *moderate* contextualist: his moderation consists in the fact that the real, possible contexts – the language games – are limited to this or that "form of life." Our language games, in particular, are limited to our own form of life. In this sense, and only in this sense, language has a centre.¹³

We formulate the position of contextual realism using Wittgenstein's own terms: "language game," "rule," "family resemblance," "form of life," philosophical "grammar," "hinge proposition." Note that what is at issue is our own analytical interpretation of these terms. The essence of the Wittgensteinian deflationary approach, broadly understood, is to lay bare the logic of language and of concepts; in turn, we try to lay bare the logic of Wittgenstein's own language and philosophy.

A language game is governed by a rule; there is such a thing as the application of the rule (a fact that already allows one to dissolve the problem of rule-following), that is, it has a normative dimension, or what Wittgenstein calls "spontaneity" – a term that can be understood as a generalization and naturalization (within the framework of a normative naturalism, itself a species of normative realism) of Kantian spontaneity, the purely intellectual (conceptual) capacity of cognition. Wittgensteinian spontaneity can be understood as the founding, post factum, of a new, authentic (correct) language game – an application of the rule. Evidently the rule (norm) applied within the language game itself serves as the standard by which it is justified.

¹³ An example of the opposite reading of Wittgenstein is the position of Robert Brandom, who holds that for Wittgenstein language is so multifarious that it has no centre at all. Within Brandom's own analytic pragmatism, by contrast, language does have a centring character (Brandom 2008, 2011).

In other words, a language game is an action – practical, in its own right, or theoretical (an act of cognition can itself be regarded as a cognitive action, a language game) – that is, a normalized (conceptualized) practice, a practice governed by a rule (a norm, a conceptual scheme). It is the application, the use, of a Wittgensteinian rule (norm, concept) in context. A judgment, in particular, is contextual precisely because it is a language game.

We can put it this way: a language game is, in general, a normalized mixture of things and language – of material, natural, social, and linguistic elements. It has a conceptual structure, a meaning, while reality itself, in which it is rooted and by which it is nourished, is “meaningless” just as it is. In this sense, for Wittgenstein, meaning is use – that is, meaning is a language game.

We call a Wittgensteinian rule the rule of a language game – not an abstract rule, but a rule rooted in reality, in context, in a language game, in a form of life. This means that it is determined – circularly, but not viciously so – by its paradigmatic (already normalized, i.e., rule-obeying) applications: the established language games. Even the most primitive, “instinctive” language game has a normative dimension; there, too, a rule is in use. Neither a purely intellectualist reduction of the rule to some abstract formulation of it (a kind of “regulism”) nor its reduction to mere behavioral regularity is possible. More complex language games and forms of life are built up out of simpler ones; but even the simplest are already authentic, normalized practices in which the subject participates, practices that arise because the subject begins to do something, to pose questions, and to try to answer them. (As noted above, the subject itself is formed on the basis of reality; it is not outside reality.) On this basis, the Wittgensteinian rule can be called “natural,” “real”: loosely speaking, it is “implicit” in reality, or, more precisely, explicit or implicit within its language game.

A language game cannot exist in isolation, as a single instance. A language game, and the rule that governs it, brings with it an entire family of language games subject to the same rule – which is just to say that there is a “family resemblance” among them. We define family resemblance as follows: family resemblance just is a (generally implicit) shared Wittgensteinian rule – the concept of family resemblance is equivalent to the concept of the rule. Where the shared rule is explicit, we can simply speak of similarity. Language games, together with their family resemblance, constitute a “form of life.”

Thus the concept of a language game already contains all the others: rule (norm), family resemblance (equivalent to rule, norm), form of life (equivalent to grammar,

rule, norm, the set of established language games) – and conversely, each of these concepts contains all the others.

Language is the application of a rule, norm, in context; there is no application of a rule, norm, concept, outside of context. This holds both for the definition of a rule, norm, concept, and for the definition of context. Context is where a norm is revealed and where it is applied – and conversely.

A language game, as the application of a norm in context, is a phenomenon involving the difference between mere appearance and reality. If the application of the norm is correct, the language game is authentic, and we are dealing with a phenomenon within which a real thing is truly given; otherwise there is illusion. A language game is not autonomous: it presupposes context, and is rooted in reality. Its norm governs it.

Within an authentic phenomenon, the thing itself is given to us – an object rooted in reality (in the broad sense: not necessarily a visual object), correctly identified by a rule, norm, concept.

Wittgensteinian rules (henceforth simply “the rule”), norms, and concepts fall under the category of the ideal. They “measure” reality. As a result of the correct application of a rule to reality, an authentic (“spontaneous,” “natural,” in Wittgenstein’s terms) language game emerges. The gap between the rule and reality – between the corresponding language game and the real object identified within it – is logical, not substantial: it is a gap between the categories of the real and the ideal, not a gap between objects of the same category, i.e., between commensurable objects. That is why it closes logically (one might also say: it closes pragmatically, in practice) – it suffices to take this categorical difference into account. This is how the Wittgensteinian problem of rule-following is solved, or rather dissolved.

In other words, a rule (norm, concept), as already noted, is determined by its paradigmatic applications, which by definition contain no gap at all. In the case of a new application of the rule (norm, concept), correctness of application just is the closing of the gap; the gap is closed provided the language game is justified *post factum*. The possibility of a correct (exact or approximate) application of a rule belongs to the very logic of the rule (norm, concept) and its application; no further, substantial, explanation is needed of how the gap between rule and application is to be closed.

What we have been discussing are the very concepts of concept and of reality,

together with the general structure of the problem of rule-following (the application of a concept, a norm). Instantiations of this problem include the hard problem in the philosophy of consciousness, the measurement problem in quantum mechanics, the “problem” of the complete formalization of mathematics, and others. Ultimately, the correct understanding, and dissolution, of these problems presupposes a correct understanding of the concept of reality – a correctly realist position.

At first glance it can seem that a full conceptualization (description, explanation) of phenomenal experience, of qualia (as felt, as “what it is like”), is impossible. This illusion results from conflating the category of the ideal – which includes norms, concepts, rules, descriptions – with the category of the real, which includes phenomenal experience. Neither can be turned into the other by definition; neither is “opposite” the other in a way that would make them commensurable, belonging to the same category; there is, properly speaking, no gap between them at all. The “explanatory gap” is closed in the correct application of the phenomenal concept developed out of experience and practice – the concept that identifies this or that kind of sensation, perception, and so on, or even this or that singular sensation or perception (there are singular concepts that allow the identification of a unique, singular experience). In the same way, the measurement problem in quantum mechanics is dissolved (see below); and, in mathematics, Gödel’s theorems show that it is impossible fully to formalize mathematics – that is, to reduce the data of mathematical reality (whatever that ultimately is) to pure, normative formalism.

Rules, norms, and concepts “measure” reality. By definition, measurement – exact or approximate, the one presupposing the other – is possible, and what is measured, as a result of measurement, is the real thing itself, not some ersatz, representation, or surrogate of it. Likewise, thought measures reality, real things: one cannot think *of* a thing without thinking of the thing itself. By definition, a thought is a thought of the thing itself (see below for more detail).

It should be noted that the measurement of reality – that is, the application of a rule – is contextual: it admits of an “error” fixed by the context of the rule and of its application (its measurement). That is, there is a contextual limit of accuracy, respecting which counts as an exact application of the rule; and even within that limit, an exact application of the rule can be more or less reliable. In particle physics, for example, the accuracy threshold at which the experimental observation of a particle counts as its discovery (as knowledge that it exists) is “five sigma”: the Higgs boson is said to have been discovered because its experimental statistical confirmation reached five sigma or better (the higher the significance, the more reliable the knowledge). In

other domains the accuracy threshold may differ – “three sigma,” say.

Likewise, the correct use of language in everyday situations depends on context. If, in one context (a geometry lesson, say), a circle drawn on the board is inexact, or not even strictly a circle – there being, in that context, a norm of what counts as a circle, an allowed margin of error within which a drawn figure still counts as a circle, or an exact circle – then in another context the very same figure might count as an exact circle. For the Platonist, the ideal circle – precise, eternal, perfect, unchanging – exists in an ideal world: that, for the Platonist, is what truly exists, and the ideal is always somehow close at hand. The Platonist’s error is to detach the norm from context, that is, to hypostatize it – to treat it in the image and likeness of surrounding bodies (except that, unlike material bodies, the Platonist’s ideas are made of immaterial substance).

A thing is identified within a language game as a determinate thing – that is, as an object given by thought. It is a tautology that one cannot think of a thing without thinking of it; and if we think of a thing, i.e., correctly apply the relevant concepts (norms, rules), we think of the thing itself, not of a “thing-for-us,” an “already-conceived thing,” or anything of the kind. In other words, both correlationism – which holds that we have access only to the correlation between subject and object, consciousness and reality, thought and thing, and not to the subject, consciousness, or thought as such, on the one hand, or the object, reality, or thing as such, on the other – and anti-correlationism – which holds that the correlation can be overcome, that access to the thing itself, as though bypassing thought altogether, is possible – share a common, false assumption: that some substantial correlation genuinely obtains and, as it were, screens off access to the thing itself (so that the thing itself turns out to be either inaccessible as such, or simply nonexistent, or accessible only with difficulty, or accessible in some special way). Both simply conflate the categories of the real and the ideal, without taking into account the logic of language, thought, truth, object, reality, and the other concepts involved (Benoist 2017, *L’adresse du réel*).

To take this logic into account is precisely the essence of the deflationary – that is, non-metaphysical – approach. The moderate deflationism that we (and, we believe, Wittgenstein and Jocelyn Benoist) endorse does not, however, deny the existence of things themselves, nor their knowability; nor does it deny that norms (rules, concepts, language) are rooted – “implicit” – in reality, and go beyond any particular language game. They function as a “summons of reality,” which is not itself a phenomenon, does not show itself, but can be expressed in language.

The “correlation” of subject (thought, consciousness) and object (reality, nature) can, and should, be understood not metaphysically but deflationarily, as the identification of an object by means of thought, from within a point of view. Outside of thought, and outside of a point of view – for every thought is perspectival, situated within some point of view – the identification of an object, thinking about it, is impossible: we cannot think of an object without thinking of it. This tautology belongs to the very logic of thinking.

Truth – the correct identification of an object, the correct application of a norm – can be understood as the “correspondence” of thought and reality, of language and reality, and so on; but this is, in fact, a logical reconstruction. Already Aristotle noted (*Metaphysics* Γ, 1011b; cited in Benoist 2013: 208) that what is knowable, thought, or measured stands in a relation such that it corresponds to the cognition, thought, or measurement of it – and that this relation is not symmetrical, though it can be artificially reversed. Cast the other way, it runs: truth, cognition, thought, perception correspond to the state of affairs (the fact), to what is cognized, thought, or measured. For Aristotle this way of putting things is a mere repetition, a tautology; and the same holds, *mutatis mutandis*, for visual experience – to say that the latter corresponds to the object perceived in it is simply to say the same thing twice. Benoist, finally, extends this observation to perception as such: it is precisely the (mis)treatment of the asymmetric relation between the perceived and the thought as though it were a substantial relation that generates the problem of the subject’s access to reality through perceptual experience.

The correct application of a norm just is truth as “conformity,” rooted in reality. We can speak of a literal correspondence only when we mean the correspondence between language and its established applications; in that case language (norms, concepts) appears naturalized, its normativity invisible.

The form of life, like all of Wittgenstein’s other concepts, is therapeutic. On the one hand, a form of life is not a positive (substantive) concept: there is no point in building a theory of forms of life, and the concept explains nothing by itself. It is used within the deflationary approach, which lays bare the logic of the use of our concepts and thereby frees us from unnecessary (pseudo-)metaphysics. On the other hand, deflationism should not be confused with reductionism: Wittgenstein’s position is anti-reductionist and anti-foundationalist. A form of life is not some more basic thing – a biological foundation, say – stripped of its social dimension. It consists of language games and has its own grammar.

Quantum Mechanics and Contextual Realism

Let us consider the simplest quantum system: a quantum bit, a system that can be in either of two states, 0 and 1, or in a linear superposition of the two. (A classical bit can only be in one of the two states, 0 or 1.) One realization of such a system is a spin- $\frac{1}{2}$ system; let us take an electron, for definiteness.

As is well known, when one measures the projection of the electron's spin onto any axis z , the observed value, with some probability, is either $-\frac{1}{2}$ (we denote the corresponding state $|0\rangle$) or $+\frac{1}{2}$ (we denote the corresponding state $|1\rangle$). The respective probabilities are fixed by the Born rule: if the wave function has the form $a|0\rangle + b|1\rangle$, where a and b are complex numbers and the function is normalized, then the probability of obtaining the value $-\frac{1}{2}$ upon measuring the spin projection equals the squared modulus of the coefficient a , and the probability of obtaining $+\frac{1}{2}$ equals the squared modulus of b .

If the system was initially in state $|0\rangle$ ($a = 1, b = 0$), measuring the projection of the spin on the z axis will, with probability 1, yield $-\frac{1}{2}$; if it was initially in state $|1\rangle$ ($a = 0, b = 1$), the measurement will, with probability 1, yield $+\frac{1}{2}$. Such states are called eigenstates of the spin projection, an operator on a two-dimensional Hilbert space consisting of linear combinations of its eigenstates. If the system was in an equal superposition of the two states, $a|0\rangle + b|1\rangle$ with, say, $a = b = 1/\sqrt{2}$, then measuring the spin projection on the z axis will yield either $-\frac{1}{2}$ or $+\frac{1}{2}$, each with probability $1/2$, and the system will accordingly pass into the state $|0\rangle$ or $|1\rangle$. This irreversible, stochastic reduction of the wave function $- a|0\rangle + b|1\rangle \rightarrow |0\rangle$ or $a|0\rangle + b|1\rangle \rightarrow |1\rangle$ – is not described by the Schrödinger equation. This is one formulation of the so-called “measurement problem” in quantum mechanics.

Within quantum mechanics, probabilities are not epistemic: they are not merely a reflection of our ignorance of some underlying matter of fact. Prior to measurement, the projection of the spin on the z axis had no determinate value at all – indeed, there is no point even in speaking of a determinate value prior to measurement. Quantum ontology differs from classical ontology in this respect: it is an ontology of “disposi-

tional background,” as this is increasingly called in the philosophical literature on quantum mechanics – an ontology of potentials. That is, unlike classical mechanics, quantum mechanics admits of no predetermined values of physical quantities; the theory implies that it makes no sense even to speak of predetermination.

Even when the system is in the eigenstate “0” or “1,” so that the outcome of measuring the spin projection is predetermined with mathematical probability 1, this predetermination is not epistemic. If we are dealing with a single system and are measuring it for the first time, then, as follows from the no-cloning theorem, its value cannot be known with certainty in advance – for otherwise we could know what state the system is in and thereby clone it. (As Michel Bitbol reminds us in *La Pratique des Possibles*, there is a difference between a reliable prediction and a prediction made with probability 1; Bitbol 2015: 331.)

It is said that the wave function – including the eigenfunctions of an operator for some physical quantity – lacks objective reality: it is not predetermined but can only be established statistically, by performing measurements on identical copies of the system. When we are dealing with a single instance of a quantum system in the pure state ψ , which may be represented as the eigenstate (with eigenvalue 1) of some projector, the function ψ is known only to the experimenter who prepared it, and cannot be known to an outside observer. Indeed, as a result of measurement the system changes its state unpredictably and irreversibly; part of the information about the initial state is irretrievably lost, and the experimenter obtains only partial information about it. (A consequence of the wave function’s lack of objective reality is precisely the impossibility of exactly copying, or cloning, an unknown state – the no-cloning theorem.)

One must therefore either accept the existence of a reality that is unknowable from the standpoint of an observer not involved in preparing the wave function, or accept that this reality itself presupposes the presence of an “interacting” observing subject: independently of the observer, the wave function cannot be regarded as objectively real, and quantum reality just is the reality of the act of preparing the state of the system. In fact, on our interpretation, what is at issue is not the interaction of observer and quantum system,¹⁴ but the measurement of a physical quantity by an observer,

¹⁴In our view, one shortcoming of the “QBist” interpretation of quantum mechanics is precisely that it construes measurement as an interaction between an observer (“agent”) and the quantum system (“the world acted upon”). Thus, on the one hand, the quantum system is treated as though it were real (otherwise, what is the observer interacting with?), while on the other hand, the observer measures only the result of *that interaction*. Within QBism, observer

within this or that context. Outside its context, a physical quantity has no determinate value. The Born rule fixes not so much the probability of the “reduction” of the wave function (a purely mathematical matter) as the probability of a transition upon the measurement of a physical quantity in a given context. Even where the mathematical probability of a transition is 1 within some context, it still makes no sense, prior to the actual measurement, to speak of a determinate value of the physical quantity.

The concept of “wave function,” then, cannot be treated as a concept in the classical sense. It is a “quantum concept,” whose very functioning presupposes the presence of an “observer,” a point of view. In quantum theory, concepts do not function as means of representing a metaphysical reality of objects existing independently of the observer, but as rules for the observer’s “interaction” with reality, and for the formation of the observer’s derivative, classical “metaphysical reality” of physical quantities possessing determinate, predetermined values. (More precisely, on our view, this is a matter of measurement in context, not of interaction – see below.) Understanding quantum mechanics thus does not consist in understanding quantum concepts in a classical manner – which is impossible – but in understanding *that* such understanding is impossible: that quantum concepts differ from classical concepts precisely in how they function.

A further argument can be given for the inapplicability of classical ontological representations even in the case of mathematically predetermined values of quantum physical quantities, where the system is in an eigenstate. Suppose that, in some superposition of eigenfunctions of a physical quantity, all the coefficients but one are very small: the approximate eigenvalue corresponding to the “large” term of the superposition is then almost predetermined in the mathematical sense. But to assume that it is thereby ontologically predetermined as well would contradict the view that, in a superposition, the values of a physical quantity are not predetermined, and that there is no sense even in speaking of their predetermination. Consequently, even when a system is in an eigenstate of a physical-quantity operator, if we are not aware of this fact, the corresponding eigenvalue cannot be regarded as predetermined; whereas if we ourselves have prepared the system in that state, and hence know that it is in it, it is correct to say that the physical quantity has a determinate value.

Thus, on our view, quantum epistemology and quantum ontology are contextual in this sense: it is only as a result of measurement that we move, with probability 1, into the corresponding context, and thereby come to know both that we are in that

and observed quantum system form two parts of a single whole (Fuchs 2018, “Notwithstanding Bohr...”; von Baeyer 2016).

context and that the spin projection now has a determinate value.

Interacting quantum systems are described in quantum mechanics by a wave function belonging to the tensor product of their respective Hilbert spaces. The quantum interaction between the spins of two electrons, for example, is described, in the general case, by an entangled wave function containing inseparable components of the spin wave functions of both electrons. Such inseparability (entanglement) is the source of the quantum correlation between the measured values of the spin projections of the two electrons – for we are not, in fact, dealing with two systems but with one. All measurements are accordingly performed on the system as a whole. The so-called correlation is not a correlation between two physical quantities pertaining to two different systems, two events, but a correlation between numerical values obtained from measurements performed on one and the same system. Michel Bitbol writes that quantum mechanics is *a*-local rather than non-local (Bitbol 2015: 329–330) – that is, instead of “non-locality” it is better to speak of holism, or inseparability.

If quantum mechanics is taken to be a universal theory, one must also take into account the interaction of the quantum system with the measuring apparatus and the observer (the “observer” can be subsumed under “measuring apparatus”), and perhaps apply quantum mechanics to the description of the universe as a whole. Such a “global” approach, however, resembles the sceptic’s attempt to give a positive justification for the existence of an “outside world.” It overlooks the fact that epistemic rationality – including the cognition of physical reality – is always local, in the sense that justified and unjustified opinion, true and false belief, knowledge and ignorance, always presuppose a system of hinge propositions which, in practice, are simply taken for granted – that is, which play a logical, not an epistemic, role.

We might also speak, not of the “localness” of rationality, but of the fact that rationality is not purely intellectual. A correct understanding of epistemic rationality as rooted in epistemic practice allows one to dissolve the sceptical problem that the sceptic tries, in vain, to solve by purely intellectual means (Pris 2018).

Knowledge of physical reality, including quantum reality, must likewise presuppose something. In the analysis of quantum phenomena, quantum theory itself, as a system of “hinge propositions,” plays the role of a Wittgensteinian rule; but of course it is not the theory alone – not merely the mathematical apparatus – that is at issue. The application of the theory brings in the measuring instrument (and/or the observer), which thus also plays a logical role (see below for more detail). The instrument and the observer can themselves be treated as a quantum system, but then a further

instrument (and/or observer) must be introduced, one that will play the logical role in question.

Suppose that the (normalized) wave function of the system's electron spin is a superposition of two (normalized) states: one in which the spin projection on the z axis equals $+\frac{1}{2}$, and one in which it equals $-\frac{1}{2}$. Then the probabilities of obtaining, upon measurement of the spin projection on the z axis, the values $+\frac{1}{2}$ and $-\frac{1}{2}$ coincide with the squared moduli of the corresponding coefficients in the wave function's decomposition. Suppose these probabilities are equal, each $1/2$.

Let us now take into account the presence of a measuring instrument and an observer interacting with the quantum system. As a result of measuring the spin projection on the z axis, the instrument, with probability $1/2$, registers either the value $+\frac{1}{2}$ or $-\frac{1}{2}$, and the observer, with probability $1/2$, observes either value, respectively. Thus, in accordance with unitary evolution, the measurement process transforms the initial tensor product of the three wave functions – (system) $\otimes$ (instrument) $\otimes$ (observer), where (system) is the wave function of the electron's spin, (instrument) that of the instrument, and (observer) that of the observer, and “ $\otimes$ ” denotes the tensor product – into the following superposition of tensor products:

$$\begin{aligned} & (\text{spin system} + \tfrac{1}{2}) \otimes (\text{spin instrument} + \tfrac{1}{2}) \otimes (\text{spin observer} + \tfrac{1}{2}) \\ & + (\text{or} -) (\text{spin system} - \tfrac{1}{2}) \otimes (\text{spin instrument} - \tfrac{1}{2}) \otimes (\text{spin observer} - \tfrac{1}{2}), \end{aligned}$$

where, for example, “spin observer $+\frac{1}{2}$ ” denotes the wave function of an observer who perceives the result $+\frac{1}{2}$, and so on. (This assumes that quantum mechanics is universal – that is, applicable both to the macroscopic instrument and to the observer.) The structure of this superposition is preserved over time.

The wave function above is called *entangled* because it cannot be represented as a tensor product of the wave functions of two separate systems. It illustrates the concept of “relative state” introduced by Everett (1957):

There does not, in general, exist anything like a single state for one subsystem of a composite system. Subsystems do not possess states that are independent of the states of the remainder of the system, so that the subsystem states are generally correlated with one another. (...) Such correlations between systems arise whenever systems interact. It is

meaningless to ask the absolute state of a subsystem – one can only ask the state relative to a given state of the remainder of the subsystem. (...) The discontinuous “jump” into an eigenstate is thus only a relative proposition, dependent upon the mode of decomposition of the total wave function into the superposition, and relative to a particularly chosen apparatus-coordinate value. So far as the complete theory is concerned, all elements of the superposition exist simultaneously, and the entire process is quite continuous. (Everett 1957: 251–254, 317–321.)

In the case before us, in the entangled wave function, the states (spin system $+\frac{1}{2}$), (spin instrument $+\frac{1}{2}$), and (spin observer $+\frac{1}{2}$) are relative to one another, as are the mutually relative states (spin system $-\frac{1}{2}$), (spin instrument $-\frac{1}{2}$), and (spin observer $-\frac{1}{2}$). We will say that these states are relative to one another within their respective contexts.

The Everett interpretation, in the broad sense (though not Everett’s own interpretation, which in our view is not metaphysical), holds that in one “world” the observer observes – and the instrument registers – that the system has spin $+\frac{1}{2}$, and in the other, $-\frac{1}{2}$; the splitting into two worlds (or into two streams of consciousness, on interpretations that introduce many minds) occurs at the moment of measurement.

On our interpretation, by contrast, what occurs at the moment of measurement is not a splitting of the world or of consciousness, but a transition into this or that context, within which a given quantum correlation is already fixed.¹⁵ Outside a context, a given correlation is not fixed – only the correlation itself is fixed. The move into one context or another corresponds to a choice of coordinate system (point of view); it is not a physical process, and in this sense the very word “transition” is not quite apt. An observer simply finds that he or she is in a certain context, within a certain point of view (in this respect, unlike in classical physics, the observer cannot choose the

¹⁵Each context has its own particular reality. As Everett writes of quantum correlation: “From the present viewpoint all elements of this superposition are equally ‘real.’ Only the observer state has changed, so as to become correlated with the state of the near system and hence naturally with that of the remote system also. The mouse does not affect the universe – only the mouse is affected” (Everett, *The Theory of the Universal Wave Function*, thesis, Princeton, 1956–57, pp. 116–117). And again: “It is not so much the system which is affected by an observation as the observer, who becomes correlated to the system” (ibid., p. 116).

context, nor return to some prior position).¹⁶ Once the “coordinate system” is fixed, the correlated value of the physical quantity is fixed. Quantum correlation is, in this sense, “coordinate-dependent” – both in the sense of the initial choice of “coordinate system,” and in the sense of the coordinate-dependence of the correlated physical quantities once that initial choice is fixed.

Note that in speaking of quantum correlation as a “coordinate” correlation rather than a physical one, we are not rejecting causal correlation as such, but only the classical causal correlation presupposed by a predetermined metaphysical reality. Clearly, the emergence of the correlation is owed to the prior (and subsequent) interaction of the quantum systems involved, and this interaction can be regarded as the cause of the non-classical (quantum) correlation; from a formal point of view, the role of cause is played by the entangled wave function. In light of the above, we will also speak of quantum correlation as a “causal-coordinate,” or “coordinate–coordinate,” correlation.

We accordingly hold that contextual realism provides the most adequate interpretation of quantum mechanics.

It should be noted that Karakostas speaks of “contextual realism” in a sense close to the one we attach to the term, with respect to quantum mechanics:

The context-dependency of quantum objects does not contradict a realistic view of the world as usually assumed. Scientific realism and quantum nonseparability are not incompatible, but the relationship between them points to the abandonment of the classical conception of physical reality and its traditional metaphysical presuppositions, most notably atomism and strict ontological reductionism. Due to the essentially context-dependent description of reality suggested by quantum mechanics, one ought to acknowledge that the patterns of nature emerge and become intelligible through the active participation of the knowing subject that, by itself, is not and cannot be perspective-

¹⁶That is, the measurement of a physical quantity depends on the choice of reference system (measurement context). We can measure it in one reference system or in another, and here the order of measurement is immaterial: we can always return to the original reference system, the original context, and obtain the same result. (In quantum mechanics this is not the case.) But once the reference system in which the measurement is made is fixed, the measurement of the same physical quantity in another reference system is thereby predetermined: there is a coordinate correlation.

independent. In this sense, the conceptualization of the nature of reality, as arising out of our most basic physical theory, calls for a kind of contextual realism that we call “active scientific realism.” (Karakostas 2004, unpublished manuscript, p. 20.)

Everett, the Theory of Relativity, and Quantum Mechanics

From the standpoint of contextual realism, as we understand it, in Einstein's theory of relativity each reference frame can, to begin with, be regarded as a point of view on reality, one that allows us to identify a certain cross-section of it, a certain measurement. In one reference frame we obtain certain lengths and time intervals; in another, different ones. In one frame two events are simultaneous; in another they are not. The reference frame fixes a point of view, a perspective, a context. There is, on the other hand, a broader context within which different points of view are themselves compared – and this, too, is a point of view. Within its own frame, reality is a reality of proper times and proper lengths, and the times and lengths measured in a moving frame of reference are treated as coordinate, conventional times and lengths, related to the proper ones by the Lorentz transformations. In other words, within a new, global context, physical quantities that were initially real turn into conventional descriptions of one and the same thing from different points of view (in different reference frames). In special relativity, it is events – points in four-dimensional Minkowski space – and the tensors of physical quantities, rather than their components in this or that reference frame, that appear as real.¹⁷ In

¹⁷Our position can be seen as a contextual reinterpretation (or even correction) of Kit Fine's "fragmentalist" position, whose existence we learned of only after arriving independently at similar views (Fine 2005; Lipton 2018). Fine, in particular, speaks of a pluralism of physical space-times: "According to the standard view, special relativity shows that spacetime is Minkowskian rather than Newtonian, and that physical processes are to be regarded as occurring within a spacetime with Minkowskian structure rather than Newtonian structure. However, from the fragmentalist point of view, special relativity shows not that the Newtonian conception of spacetime is mistaken, but that the idea that there is a single, unified spacetime is mistaken. We must instead depict physical processes as occurring within a multiplicity of spacetime frameworks, each of which shares a common ontology of spacetime locations and each of which is Newtonian in its own structure, while differing from the others in the spatial and temporal relations it assigns between spacetime locations" (Fine 2005: 306). Unlike Fine, however, we hold that what is genuinely shared across such cases is not an ontology but fragments of reality – in particular, unconceptualized "events." Ontology, what really exists, depends on context.

special relativity, the “correlation” between physical quantities in different reference frames is coordinate – a matter of the context of measurement¹⁸ – rather than a physical (material) one; its “cause,” one might say, is the Lorentz transformation (the corresponding symmetry, or the corresponding four-tensor).

Everett carries this idea of relativity over into quantum mechanics. In quantum mechanics, the role played by Minkowski space is played by Hilbert space. A basis of vectors – wave functions that are eigenfunctions of some physical quantity, a self-adjoint operator – in Hilbert space plays the role that a reference frame plays in the theory of relativity; a unitary transformation plays the role of a symmetry transformation. Quantum physical quantities are represented as matrices in different reference frames (bases), and the correlation between the components of these matrices in different frames is coordinate. At the same time, unlike in special relativity, measuring these components in a single reference frame means that they are not interchangeable within the corresponding context. If the coordinate basis in Hilbert space consists of the eigenfunctions of an operator P for some physical quantity, then only eigenfunctions of P can be observed in that basis, with probabilities fixed by the Born rule.¹⁹ A quantum event – a measurement yielding a specific value of P – can be regarded as a measurement in context (or as a transition into a context). The measurement result is not predetermined – in contrast to the classical case, where physical values are predetermined and can be measured in any order. On this view, the quantum transition from the absence of predetermination to determinacy is not a physical process but the actualization (realization) of one or another value of a physical quantity.

Given the analogy just drawn, the so-called quantum correlation (the EPR paradox) can likewise be treated as a coordinate, rather than physical, correlation; its “cause”

¹⁸That is, the measurement of a physical quantity depends on the choice of reference frame (measurement context). We can measure it in one reference frame, or in another; here the order of measurement is immaterial, and we can always return to the original reference frame, the original context, and obtain the same result. (In quantum mechanics this is not so.) But once the reference frame in which the measurement is made is fixed, the value of the same physical quantity in another reference frame is thereby predetermined: there is a coordinate correlation.

¹⁹This is the context of measurement: P is measured in whatever order it is measured. If, say, Q does not commute with P , then measuring P first and then Q is not the same as measuring Q first and then P – quantum mechanics is non-commutative. Unlike in special relativity, where the order in which quantities are measured is immaterial, in quantum mechanics the order of measurement matters.

is the wave function.²⁰ Indeed, in an entangled quantum system it is impossible to isolate independent subsystems (independent wave functions of subsystems); strictly speaking, one cannot properly speak of “subsystems” at all. As Everett writes, the wave function of one subsystem can be chosen arbitrarily; the wave function of the other subsystem is then determined relative to the wave function already chosen for the first, in such a way that, across all possible choices (contexts), the wave function of the composite system remains unchanged (Everett 1957). This relativity is analogous to the dependence on the choice of reference frame in Einstein’s theory of relativity. It is senseless to ask about the absolute state of a subsystem (an absolute context, an absolute coordinate system, as in special relativity); one can only ask about its relative state – its state relative to a given state of the other subsystem. Physical quantities have different values in different reference frames (contexts), but there is a definite relation between their values in different frames (Everett 1957). At the same time, the measurement effects the actualization of a point of view. In this sense quantum reality turns out to be “fragmented” (cf. above), or, more precisely, contextualized.

A measuring device, considered (and used) strictly as a measuring device, cannot be regarded as interacting with a quantum system – it is measuring it. Measurement as such is not an interaction, because, by definition, it belongs, together with theory and concepts, to the category of the ideal, the normative, rather than the real. The “reduction” of the system’s wave function is therefore not a real physical process. If, instead, we consider the interaction of a measuring device with a quantum system, the device loses its status as a measuring device used by the subject performing the measurement, and in order to obtain a specific measurement we must introduce a further measuring device, one that measures the interaction of the first device with the quantum system. This regress stops logically, because we pass from the real to the ideal domain: measurement is treated as measurement, not as interaction. In the particular case of measuring a quantum correlation, what occurs is not a physical transformation of the original quantum system, but a transition to a possible context in which the “correlation” is already fixed. The correlation as such is always fixed; what is not fixed are the specific values of the correlated quantities – that is, the context of the correlation. Within that context, however, they too are fixed.

²⁰We put the word “cause” in quotation marks, though it is also possible to speak of cause in a literal, if broad, sense. Quantum correlation is not a correlation between autonomous events belonging to some “external reality,” so to speak, events in a metaphysical sense – it is a correlation between the results of observations.

A Pragmatic Look at Everett's Interpretation

We have elsewhere proposed a pragmatic “demystification” of Everett’s interpretation – or, more precisely, of its metaphysical, many-worlds reading – in terms of quantum theory understood as a Wittgensteinian rule (henceforth: a *contextual rule*, or c-rule) and its application (Pris 2016). A pragmatic reading of Everett’s interpretation has also been proposed by Michel Bitbol (Bitbol 2015).

For Everett, all the “branches” of the superposition of eigenfunctions of a physical quantity are equally “actual,” and none affects any other; none is more real than the rest. There is accordingly no need to suppose that, in the process of measurement, all but one branch is somehow destroyed. This means that within Everett’s quantum meta-theory there is no “external observer,” no Born probability postulate, and no primitive transition from the “possible” to the “actual”: the Born rule is not postulated but derived, from the weights of the components of the superposition together with symmetry considerations. (Note that Everett’s own proposed derivation of the Born rule is not fully satisfactory.) The statistical interpretation of the theory is secondary: “The formalism invites one to construct the formal theory first, and to supply the statistical interpretation later” (Everett 1957: 21).

In essence, Everett’s original insight is simply to state that the result of a given measurement is relative: it depends on the choice of observer. A metaphysical reading of this analytic observation introduces a plurality of parallel worlds, in each of which one or another measurement result is observed (or a plurality of parallel consciousnesses, each registering one or another result), each such world or consciousness enjoying the same ontological status (see, e.g., DeWitt 1973). This reading comes paired with a traditional, extensional, semantic interpretation of modality in terms of possible worlds – and it does not solve the measurement problem.

The metaphysical difficulties in interpreting quantum mechanics dissolve once one takes into account the pragmatics of language and both ordinary and scientific practice. The transition from the possible to the actual concerns, in fact, not the theory

but its application – the pragmatic-practical level, the level of the “measurement” of reality. In our terms, a theory, as a rule (concept, norm), does not apply to something specific “out there in the external world”; it applies to reality. It simply applies – it has already been applied, within the relevant language game, in some context. A transition from one language game to another is a transition from one context to another; the object to which the theory applies, as a c-rule, is secondary, and its application to a predetermined object is itself a rational reconstruction of an already well-established language game. Within the correct application of the theory (rule, norm, conceptual scheme), the gap between the theory and the corresponding language game is closed from the outset – and this holds for every language game governed by that rule.

In just this way, by means of its pragmatic reinterpretation, Everett’s interpretation can be demystified (Pris 2016). This is in keeping with Everett’s own observation that many of the paradoxes of quantum mechanics are merely apparent, and become clear and disappear within his meta-theory: “Fictitious paradoxes like that of Einstein, Podolsky, and Rosen ... are easily investigated and clarified in the present scheme” (Everett 1957: 462).

A similar “pragmatic–pragmatic” and “pragmatic–modal” approach to interpreting Everett, cast “in terms of the pragmatics of configurations of intersubjective expectation” and a “parallelism between objectivist and performative (pragmatic–pragmatic) settings,” is proposed by Bitbol (Bitbol 2015: 6). For Bitbol, quantum theory does not describe an external reality but provides a set of rules for predicting the possible effects of interacting with reality, of experimental activity – for us, recall, this is just what it is for the theory to be a norm/rule. The difficulties in understanding quantum mechanics stem from the fact that it is approached within the classical epistemological paradigm (Bitbol 2015). In particular, the problem of quantum “moments” or “events” (the Schrödinger equation fixes no such moment) is thereby dissolved: the moment in question is fixed within the performative setting (Bitbol 2015). (In our own terms: the temporal moment of a quantum phenomenon belongs to the language game of applying quantum theory; the moment at which a quantum event occurs is thus not something quantum theory itself determines.)

The pragmatic approach implies a new paradigm of knowledge, elements of which are already present in Bohr: it introduces no fixed line of demarcation between the observed and the observer, no dualism of a cognizing subject set over against an object of cognition (Bitbol 2015: 426). Everett’s interpretation fits this paradigm in the most natural way.

The metaphysical “view from outside” is, in fact, a meta-theoretical reconstruction. Even the simple visual observation of an ordinary object – a house, say – is inherently perspectival: observation, by its very nature and by definition, always takes place from some perspective. The hypothesis of a point of view that absorbs, or encompasses, all possible points of view is itself a theoretical construct (Benoist 2016b, *Realismus und Metaphysik*). Theory, classical mechanics included, is applied to reality on each occasion from within this or that “language game,” this or that perspective – one that does not obscure the object under study but rather reveals one or another of its aspects. Some hopeless, absolutist view from nowhere is impossible, and makes no sense; not, as Kant thought, because we are “finite,” but because any cognition, any thought of something whatever, is by definition cognition, thought, from within a perspective, a point of view. (This position is defended, for example, by Jocelyn Benoist; Benoist 2016b; see also Benoist 2016a, 2017.)

In quantum mechanics this is shown most clearly of all, since it is impossible to observe the state of a quantum system simultaneously in different “reference frames,” from different points of view: the choice of one point of view excludes the choice of another. In other words, this or that particular result of measuring a physical quantity implies a determinate “reference frame,” point of view, on the part of the observer – the observer cannot, so to speak, be separated from it.

In a certain way the same holds in the classical case. Within special relativity, for instance, the lengths and time intervals between two events differ from the point of view of different inertial frames. There are two ways to look at this. In one metacontext (from one and the same meta-point-of-view) we are indeed dealing with different – contextual, i.e., reference-frame-dependent – realities: different lengths and time intervals. In another metacontext, that of a (meta-)comparison of different reference frames, we are dealing with one and the same reality (two events), described from different points of view, between which a correspondence can be established by means of the Lorentz transformation.²¹

The only difference in the quantum case is that there need be no unambiguous transition from one point of view to another.

An observer (quantum or otherwise) is not subjective; it is an objective condition.

²¹ Similarly, from one point of view a table is a macroscopic object – one reality – and from another a collection of atoms – a different, contextual reality. From a third point of view, we are dealing with one and the same object (the same reality), described in two different ways: macroscopically and microscopically.

Here it is worth recalling Aristotle, for whom a phenomenon has the following “grammar”: a phenomenon is always the phenomenon of something, for someone, somewhere, at some time, in some manner: “(…) what appears to be the case is not [in general] so, but only for the one to whom it appears, at the time it appears, and in the way and manner in which it appears” (Aristotle, *Metaphysics* Γ (IV), 6, 1011a23–24). The quantum phenomenon, which involves the measurement of quantum physical quantities, is no exception.

The difference between classical and quantum mechanics can be put as follows. In classical mechanics, a “measurement result” adds nothing to its ontology: the observer simply, passively registers what is already there. If the outcome of a measurement shows a physical quantity to have a certain value, that value is assumed to have existed prior to the measurement as well. In this sense, and only this sense, it is independent of the observer, and in this sense, and only this sense, one may speak of a correspondence between the classical language of description and classical ontology.

In quantum mechanics, a “measurement result” has a different status. It is an event that exists, so to speak, only in its relevance. It generally makes no sense to say that the value obtained by measuring a physical quantity already existed prior to the act of measurement. We can only speak of a reciprocal correspondence between the wave function and the quantum system it describes – and even this way of putting it is contestable. Strictly speaking, the wave function “corresponds” to a quantum system only within the context of its preparation: the wave function is ideal, and the quantum system is real. Outside the context of the wave function’s use, it therefore makes no sense to speak of a correspondence between them.²²

A pragmatic approach allows for a better understanding of the status of an “event,” and, in particular, of the “event” that actually arises in a laboratory experiment.

²²Bas van Fraassen makes a similar argument against the correspondence of theory and reality, in support of his constructive empiricism.

Quantum Event

An unconceptualized singular fragment of reality has ipseity – it is itself – but no specificity: it cannot be characterized in any way. A particular table, for instance, is not merely a fragment of reality but a fragment of *conceptualized*, identified reality; it is characterized as a “table.” For someone who has never seen a table and has no concept of one, it can only be a fragment of reality about which nothing, or almost nothing, can be said, and which cannot, in one way or another, be put to use. Nevertheless, an unconceptualized thing, though it lacks identity, does not thereby cease to exist.

A fragment of reality (the same table) can carry a minimal, say spatial and temporal, conceptualization: it can be “something” within a certain region of space-time. A space-time characterization is already a form of characterization.

Taking the foregoing into account, the concept of an event can be understood in two different ways. If by “event” we mean “something” that happens in space and time, then such an event remains, for the most part, an unconceptualized fragment of reality. If, on the other hand, by “(actual) event” we mean something determinate that happens at a given moment of time (and perhaps at a given place in space), then such an event is a full-fledged space-time event possessing a space-time identity. Such an event may be more or less specific – that is, a real object, definite and concrete (in the sense of being rooted in reality), may be given within it, to a greater or lesser degree of specificity. A space-time point in the four-dimensional manifold, by contrast, is not an element of reality but a mathematical element of its representation: it is ideal.

Since an “actual event” presupposes the use of concepts (as rules), we can also speak of it, in the Wittgensteinian sense, as a rule-governed “language game,” as a phenomenon (a measurement of reality by a norm), or as a fact. In this way we bring together the concepts of “event,” “phenomenon,” “fact,” and “language game.”

Note that “fact” is often understood as a true sentence describing, or representing, an event that has already taken place; on this understanding, a “fact” is in a sense

detached from the real event – the fact turns out to be decontextualized. On our view, by contrast, “fact,” as the real event itself, presupposes the application of concepts in context, and is accordingly rooted in reality. In this “fact,” the logical gap between the conceptual and the real, between the event and its description, is closed from the outset.

Thus we do not distinguish between the linguistic representation of a conceptualized event – the “fact” – and the “event” itself. Such a distinction would only be needed if there existed absolute “effective events,” expressed by facts. But no particular event arises, in itself, in some “external reality,” because reality itself possesses no such determinacy. An event is identified, in context, as a result of applying concepts, a theory; a given (already identified) event is not predetermined – its actualization is not a selection from some “stockpile” of predetermined abstract possibilities. Bitbol, for instance, holds that an event does not occur in nature independently of the conditions of its observation and of “collective (intersubjective) certification”: “What is an actual event, if not that which is agreed upon by the numerous subjects capable of recognizing it? (Fr. *aptés au constat*)” (Bitbol 2015: 7).

One might raise the general question: “What is there?” Let us first note the most obvious kind, or mode, of existence. The computer I am looking at exists at the moment I look at it; I also know that it existed for some time before this moment, and will exist for some time after it. Realism about the past, and realism about the future, are both sensible positions – though the further we move from the present, the less reliable our knowledge becomes, and gradually shades into mere opinion.

Existence as a determinate reality here and now is an event, or a phenomenon, within which an object – in our case, the computer – is given; this involves the application of a concept, the conceptual “dimension” of reality. The past and the future can be measured in the same way.

The actual state of things – what happens here and now, in space and time – is real, provided it is correctly identified, provided it is not an illusion: that is simply what it is. What has existed in the past, or will exist in the future, is likewise real, if it really did or will exist; but these latter kinds of reality differ in nature both from the present and from one another. Reality can have different natures.

Above we distinguished between a (non-conceptualized) fragment of reality and a conceptualized fragment of reality, and introduced the concept of “event” in the sense of a conceptualized fragment of reality. We interpret what Bitbol calls an “effective

event” as an unconceptualized fragment of reality (Bitbol 2015).

The concept of an event can be put to use within a theory. One speaks, for example, of events in space and time within Newtonian mechanics, of space-time events – points of space-time – within the (special and general) theory of relativity, and likewise within quantum theories of gravity, and, more generally, within any theory involving space and time. In classical mechanics, a material point traces out a trajectory consisting of space-time events. But the concept of an event need not figure in a theory at all. In quantum mechanics, a particle at a given time is, as it were, simultaneously at different points in space; it therefore makes sense to speak of the event “at this point in time and this point in space” only at the moment of measurement, not within the theory itself. In this sense there are no events in quantum field theory either – that is, in general, an event belongs to the pragmatic-practical domain, the domain of reality, rather than to theory. The presence of space and time within a theory is accordingly not necessary; it is said that some theories of quantum gravity dispense with space or time altogether. Moreover, even classical theories can be formulated in a “timeless” manner: Einstein’s equations in general relativity, the Schrödinger equation, and the equations of classical mechanics can all be written in a form that does not contain time as an independent variable (Rovelli 2018a).

The introduction of time and space becomes unavoidable once we apply a theory in practice, to describe reality, physical phenomena: we observe this or that value of a physical quantity at some point in time and some region of space. Events pertaining to a person’s inner world likewise occur, at least, in time (the “space” of such an event might be called the place and the circumstances in which the person finds himself).

General Preconditions of Metaphysical Realism and Anti-Realism

Traditional realism and anti-realism are both radical metaphysical positions. Elements of the two can be mixed in various proportions, yielding intermediate positions. Conceptual analysis makes it possible to bring these positions closer together by identifying, and eliminating, their false presuppositions.

Neither position distinguishes between the category of the ideal, to which norms belong, and that of the real. In other words, both positions ignore the normative dimension of phenomena, the contextuality of ontology, and the engagement of the subject.

Anti-realism, in its various forms – idealist, positivist, instrumentalist, pragmatist, phenomenological, linguistic, semantic, and so on – is a reflexive position: attention is directed primarily at the means by which reality is measured – language, conceptual schemes, structures of perception, the “organization” of experience, and so on. As a consequence, the anti-realist does not try, as the realist does, to understand the structure of the world and its laws, but only to describe or predict “phenomena,” “facts.” For the instrumentalist, physical theory is merely a predictive tool; questions about the relation between theory and reality, about the nature of the predicted phenomena, about real things themselves, are simply not raised. In other words, the anti-realist does not take his own attitudes, concepts, and theories seriously enough – he is insufficiently engaged. Because the relation between language, conceptual schemes, norms/rules, and reality goes unexamined, the former are treated as something external to what they express, describe, or regulate. For the linguistic idealist or constructivist, for example, language and our conceptual schemes simply define what exists.

Engagement, like action – if it is to be genuine action, possible only within reality – implies a realist position; and conversely, a genuine realism can only be active, and implies the engagement of the subject. It is realism, not idealism, that presupposes the existence of a genuine ideal (whether lofty ideals or ordinary norms). Benoist asks, rhetorically: “What would reality be, without the ideal?” (Benoist 2018, Preface).

Bitbol, for his part, writes that the anti-realist position carries an ethical cost (Bitbol 1994).

The anti-realist and the realist may use the same terms – “phenomenon,” “fact,” “reality,” “object,” “referent,” “truth,” and so on – but understand them differently. Yet the definitions of these notions cannot simply be arbitrary; divergence in definition is itself a consequence of the differing presuppositions of the two positions.

Take the concept of a phenomenon, for example – a concept introduced by Plato (Benoist 2016). Plato discovered that every phenomenon has a normative structure: a phenomenon presupposes the distinction between appearance and reality (and it was in this way that he introduced the notion of being into philosophy). Appearance may or may not correspond to reality. Aristotle developed this concept further; for him a phenomenon has the following logic: “(...) what appears to be the case is not [in general] so, but only for the one to whom it appears, at the time it appears, and in the way and manner in which it appears” (Aristotle, *Metaphysics* Γ (IV), 6, 1011a23–24). Within contextual realism – the position we take to be correct – we likewise interpret the phenomenon as a language game: as the measurement of the perceived by a norm. The real object is given only within a correct language game, a phenomenon that is not autonomous but rooted in reality.

For the subjective anti-realist, appearance means subjective sense-data; for the objective anti-realist, it means the objective data of measuring instruments (objectivity here being understood as the intersubjectivity of observational data). The positivist tries to organize “observable facts,” understood in a shallow sense: for the positivist the “phenomenon” has no depth. The phenomenologist, by contrast, treats the phenomenon as something autonomous, absolutizing appearance as though it could exist by itself and enjoy the highest possible credibility; the phenomenologist naturalizes the normativity (the logical structure) of the phenomenon, turning it into a “physics” of the phenomenon (see the critique of Jean-Luc Marion’s phenomenology in Benoist 2003 and Benoist 2016, *Logique du phénomène*). Twentieth-century phenomenology, in trying to rid itself of the subject’s participation in the phenomenon, arrives at the opposite result: it turns the phenomenon into pure subjectivity.

The anti-realist position contains a grain of truth: the “essence of phenomena” is not some special metaphysical essence. What the anti-realist denies, however, is that the real thing itself is given within the phenomenon – that the relations among the aspects of experience identify the real thing. And when the anti-realist does make use of the notion of reality, it carries, for him, some specific meaning of its own.

As noted above, the notion of “reality” cannot have just any meaning whatever: its meaning is that of a categorical concept – reality is what it is. At the same time, this concept admits an unlimited number of specific uses. For Wittgenstein, Austin, Quine, Jocelyn Benoist (Benoist 2011), and many others – including the well-known theoretical physicist Carlo Rovelli (Rovelli 2018, “Space is blue and birds fly through it”; Rovelli 2018, “Space and time in loop quantum gravity”) – the word “real” has many meanings. We understand this claim not in the sense that the concept of reality itself is multiple, but in the sense that there exist different types (regions, aspects) of reality – that is, in the sense that the word “real” has different meanings-in-use. In much the same sense one might understand the following remark of Bohr’s, though it strikes us as ambiguous: “The word ‘reality’ is also a word, we must learn to use it correctly” (Petersen 1985: 302, as cited in Mamchur 2014).

Metaphysical realists and anti-realists each fasten onto certain aspects of the phenomenon, detaching them from one another and from context, and either ignore or hypostatize the normative dimension of the phenomenon, conflating the ideal (norms, rules, concepts, language) with the real. As a consequence, the metaphysical realist and the Platonist alike take the real object to be a meaningful object external to the subject: for the former, this is the material or natural world in a broad sense; for the latter, the world of ideas. Both worlds are taken to unambiguously fix the language required to describe them (representations, expressions).

By hypostatizing the ideal (concepts, language, norms, rules), the Platonist treats it as a special kind of reality. In fact, an ideal “object” (we use “object” here in a very broad sense, to cover concepts as well) – provided it is not a pseudo-object – exists only within the context in which it is rooted.²³ Metaphysical realists, for their part – and this is the other side of the same coin – forget that any real object has a (determinate) meaning only in context (a fact that can, in particular circumstances, be lost sight of, but which is always present). The real object is given only from within this or that perspective, point of view, as the realization of an ideal “object” (that is, of norms, rules, a concept). There is no ready-made, already-meaningful world outside us, with its own laws and organization, existing regardless of our existence or our means of cognition. In this sense, knowledge is not passive but active. The metaphysical realist tries to imagine the existence of a meaningful outer world independent of intellect, sense-perception, and experiment – as though something could be meaningful independently of thought altogether. He tries to uncover the “essence” of phenomena while forgetting the ways in which things are identified,

²³For us, strictly speaking, there are only real objects. “Ideal objects” – concepts, norms, rules – are not themselves identified as objects; rather, they are used to identify objects.

detaching the real object from the language, concepts, or theory that alone lend it determinacy (rather than, as the anti-realist supposes, constructing it). This is how a metaphysical idol is born – a metaphysical object of the outer world. This, in turn, gives rise to the idea that an object, or a type of entity, might in principle be unknowable. But an object that is, in principle, unknowable is not really an object at all – it is a metaphysical fiction. An object that is unobservable or unknowable in principle (as opposed to merely in practice) cannot exist – not in the sense that there is some obstacle, for one reason or another, to its existing, but in the sense that, strictly speaking, the very supposition makes no sense.

Let us note one further kind of “realism,” which, strictly speaking, is itself a kind of idealism. Semantic realism, in Dummett’s sense, holds that the terms of any sentence have referents in the world, and that the sentence itself has determinate truth conditions, whether or not we are able, even in principle, to establish its truth or falsity. On this view the truth of a proposition is fixed by factors that may lie beyond our reach; for Dummett, truth is a non-epistemic concept, one that does not depend on our capacity to establish or verify it. The principle of bivalence is a (non-obligatory) consequence of this non-epistemic conception of truth (Dummett 1982). Semantic realism can be regarded as a linguistic consequence of metaphysical realism; indeed, under certain conditions there is an even tighter connection between semantic realism – which attributes a determinate truth-value to sentences (or statements) whether or not they can be known – and metaphysical realism – which asserts that there are real things underlying that content. For Bolzano, for instance, the two positions are equivalent (Bolzano 1837; see the discussion in Benoist 2019, *Absolument vrai*). Semantic realism proceeds from a pure semantics that takes no account of pragmatics – that is, of semantics as rooted in reality. It is thus, in effect, a form of idealism.

The semantic anti-realist, by contrast, holds that sentences have referents only where there exist empirical procedures for reidentifying them, and that sentences (statements) possess determinate truth-values only where there exist empirical procedures for verifying them; the principle of bivalence is accordingly rejected. According to Bitbol, for the anti-realist, points of reference are “poles of stability” within the flux of phenomena, or invariant structures that allow phenomena to be organized (Bitbol 1994).

This form of anti-realism is itself a semantic idealism, one that treats meaning as existing in itself. The position of Jocelyn Benoist, which we share, can be put briefly as follows. Reality and meaning belong to different categories. Meaning in itself is ideal; but real meaning has real conditions of existence (it is only in this sense

that it can be called “real”). There is accordingly no point in speaking either of a meaningless reality or of reality’s “impact” on our semantic constructions and opinions. The “problem of access” to reality is likewise a pseudo-problem: we are part of reality, and are in contact with it from the outset. The real task is to give reality meaning from within a perspective (a context). A hopeless view “from nowhere” makes no sense. At the same time, a perspective does not obstruct access to the thing itself, as the traditional picture supposes – on the contrary, it is precisely what makes such access possible. Language and meaning are not a kind of veil interposed between subject and reality; on the contrary, they are what allow us (correctly or incorrectly) to “measure” reality, giving us access to the things themselves. Every view of reality is perspectival. In other words, Benoist rejects the idea of an absolute, scale-free view of reality, rejects the thesis of the sheer finitude of our cognition, and rejects the correlationism so prevalent in continental philosophy. (See further Benoist 2016, *Realismus und Metaphysik*.)

Normative Pragmatism Instead of Traditional Realism and Representationalism

Quantum-mechanical paradoxes arise from attempts to answer a question that already presupposes an objective quantum reality, existing independently of quantum mechanics and merely described (represented) by it. That is, these paradoxes arise within the traditional epistemological paradigm, one that operates with the notion of representation as a mediator between subject and reality, together with a metaphysical notion of reality as a fixed totality of predetermined entities – objects, properties, relations, and so on.

A pragmatic interpretation rejects metaphysical realism and representationalism – and with them the epistemological “problem of access” to reality (Benoist 2011) that besets classical epistemology. In place of constructive metaphysical solutions, it proposes a path of reflection and analysis.

A detailed study of the pragmatic and practical procedures underlying quantum mechanics has been undertaken by Bächtold (2009) (for the idea of a pragmatic interpretation of quantum mechanics, see also Pris 2008). For Bitbol, a pragmatic “proto-interpretation” allows one to sidestep conceptual difficulties altogether: quantum mechanics should be understood as “the practice of orientation and the choice of perspective within a given environment” (Bitbol 2015: 8).

At first glance, then, there appears to be an obvious “gap” between quantum theory and classical theories, which likewise offer a deterministic picture of the physical world. Quantum probabilities differ from classical probabilities in that the latter are taken to be epistemic (precise knowledge is often difficult, sometimes practically impossible, to obtain – but it is assumed that such knowledge is possible in principle).

In fact, on the correct view of physical theory, of physical practice, and of the concept of reality, this apparent fundamental difference between classical and quantum theory disappears. Indeed, it is precisely quantum theory that allows the correct, deeper view of physical reality to come to light. The law of probability, like physical laws

generally, should accordingly be seen simply as a further rule for measuring reality.²⁴

Many physicists have suggested that metaphysical realism ought simply to be abandoned. Smerlak and Rovelli, for instance, propose abandoning Einsteinian “realism” within a “relational” interpretation of quantum mechanics, arguing that only space-time events “here and now,” not the wave function, have ontological status, and that it is nonetheless possible to satisfy the conditions of completeness, locality,²⁵ and separability (Smerlak 2007; see also Rovelli 2015; Martin-Dussaud 2018).

As for locality itself, it is well known that Bell showed, in 1964, that the quantum correlations arising from the entanglement of the quantum states of physical systems cannot be accounted for within a theory of local hidden variables (Bell 1964) – which is to say that realism and the locality of predetermined (quantum-object) properties are incompatible. Bitbol points out that, in a 1981 paper, Bell obtains an even more striking result: quantum mechanics rules out the joint satisfaction of the reality of experimental events (understood here in the metaphysical sense) and their locality (Bell 1981; Bitbol 2015).

This is consistent with our own contextual approach. As stated in the previous chapter, a quantum event, like a quantum object endowed with determinate properties, is not predetermined – only metaphysical realism treats it as predetermined – but arises within a context. The realism (i.e., the metaphysical realism) of experimental events is likewise rejected by Bitbol, notwithstanding the fact that this is sometimes thought to conflict with a minimal (empirical) realism, which, strictly speaking, is already itself a form of anti-realism – so that rejecting even that minimal, empirical reality of events looks, at first sight, like a radical anti-realism (Bitbol 2015; see also Bitbol 1983, where he rejects the intrinsic reality of experimental events). Bitbol further shows

²⁴Our view bears a certain resemblance to QBism, a form of quantum Bayesianism, which likewise holds that the Born rule is a normative statement, and that theory is a tool a subject uses to work with, and to guide, expectations shaped by aspects of physical reality. QBism, however, is an anti-realist, even subjectivist, approach (Fuchs 2017).

²⁵The paper by Martin-Dussaud (2018) distinguishes five distinct, though closely related, notions of locality, which are not all equivalent: (1) signals cannot propagate faster than light; (2) the spatial separation of causes and their effects is bounded by the speed of light; (3) quantum systems separated by a space-like interval do not affect one another; (4) interaction is possible only “point-to-point,” at a single point of space-time; (5) local variables associated with regions of space separated by a space-like interval commute. Our interpretation of quantum mechanics, within the framework of contextual realism, is compatible with all five of these notions of locality.

that neither William James's radical empiricism nor a radical scientific realism about theoretical entities – though both dispense with the notion of a real experimental event – offers a satisfactory approach to understanding quantum mechanics (Bitbol 2015).²⁶

In short, the first of these approaches holds that there is only direct experience at a given moment in time (hence no predetermined event): past quantum events have no reality in themselves, but depend, rather, on the procedures by which they are reconstructed relative to present experience – they are conceived only post factum. In other words, what is really at issue is an intersubjective agreement reached in the present. “Quantum correlation,” on this view, is a post-factum reconstruction rather than a genuine correlation between events.

Radical scientific realism about quantum mechanics, for its part, most often takes as real a wave function that evolves continuously and deterministically in accordance with the Schrödinger equation – that is, it treats the wave function as describing the real state of the quantum system, from which standpoint there simply are no events. This approach, however, faces the problem of connecting the formalism to specific, experimentally observed events.

²⁶American pragmatists – Peirce, James, and Dewey, and James above all – are drawn upon by Fuchs in analyzing the notion of a quantum phenomenon and, in particular, Bohr's notion of a phenomenon, as part of his QBism (Fuchs 2018). We would argue that QBism retains essential elements of anti-realism that could be addressed from within our contextual approach.

From Metaphysical Solutions of the Measurement Problem to Its “Deflationary” Elimination

Suppose we measure the physical quantity X and obtain some value a ; we then know that the system is in the eigenstate F of the operator X , so that $XF = aF$. Suppose we then measure the physical quantity Y and obtain the value b ; we now know that the system is in the eigenstate F' of the operator Y : $YF' = bF'$. The following question then arises: how did the transition from one state to the other occur – the transition from F to F' ? As a result of this transition, the dispositions of the quantum system, and its potentiality, have changed. Formally, this change is described by a reduction of the wave function, one that is not governed by the Schrödinger equation. The problem is how this reduction is to be understood.

The classical notion of a mutual correspondence between reality and the theory that “reflects” it can be called an “outside point of view.” Classical mechanics creates the illusion that such a point of view is possible – that this theory somehow fully reflects the reality of moving material bodies, such as the reality of the moving planets of the solar system.

There are “holistic” interpretations of quantum mechanics that likewise accept this point of view “from outside.” These include, for example, the Bohmian interpretation, on which micro-particles move along trajectories within a guiding-wave field and possess hidden values of velocity and position (here we set aside the original ontological motivation of Bohm’s interpretation), and the metaphysical interpretation of Everett, understood in terms of a plurality of worlds or consciousnesses, which we have already discussed above (Everett 1957). According to the many-worlds interpretation of quantum mechanics, all possible outcomes of a measurement are indeed realized, in “parallel” worlds into which our world splits at the moment of measurement, or in “parallel” consciousnesses into which the observer’s consciousness splits at that same moment. In terms of a multiplicity of consciousnesses (mental pluralism), a proponent of Everett’s interpretation is David Albert (Albert 1983, 1987); his approach shares with other metaphysical approaches the difficulties of the traditional theory of knowledge that we discussed above (Bitbol 2000a, 2015). In fact, Everett’s

own original interpretation, as noted earlier, is not metaphysical, and its metaphysical interpreters can be demystified within the framework of Wittgensteinian pragmatism and realism (Pris 2016).

Niels Bohr resolves the measurement problem by an epistemological (but not ontological) division of reality into two parts: one part, described by quantum mechanics; the other – pertaining to the measuring instrument (the observer) – described by classical physics, using classical concepts. The boundary between the two, however, depends on context. Such a conceptual dualism sits uneasily with the universality of quantum mechanics (even granting that Bohr himself held all of reality to be quantum in ontological terms).

Von Neumann tried to give quantum mechanics a fully universal character. He developed a formalism for quantum mechanics applicable to a closed system observed from outside it, in which classical concepts play no role, but the dualism of subject (observer) and object (quantum system) is preserved, even though the line dividing them remains conventional (von Neumann 1964). One might try to eliminate this dualism by treating the interaction between a quantum system and a measuring device as itself a quantum-mechanical interaction; this, however, does not yield a specific value for the physical quantity being measured – to obtain a specific value, one must introduce a second-order observer, and so on: an infinite regress results.

Attempts to eliminate von Neumann's infinite regress by introducing a notion of self-monitoring have likewise failed (Bitbol 2015). Other attempts have tried to eliminate subject/object dualism by drawing a dividing line between a quantum system with a small, finite number of degrees of freedom and an environment with a very large, almost infinite, number of degrees of freedom (the observer being assigned to the environment); as environment, one might take the entire universe surrounding the quantum system in question. Such a quantum system, however, will never be closed (only the universe as a whole would be closed), and an open system requires a generalization of von Neumann's formalism. Such generalized formalisms exist: they describe open, finite systems interacting with an unbounded surrounding environment, in which the quantum system and its environment are homogeneous, of the same physical nature – which is to say that the traditional dualism of subject and object is eliminated (Primas 1990). Nevertheless, the need to treat the universe as a whole (a kind of global holism) remains an unsatisfactory feature of this approach.

The successful application of quantum mechanics, together with the impossibility of satisfactorily resolving the “measurement problem” by treating measurement

as a physical or mental process, suggests that this problem is, in fact, a matter of philosophical logic, and can be resolved “deflationarily” with the help of a therapeutic conceptual analysis – one whose application is inextricably tied to an understanding of pragmatic, practical preconditions.

From a logical point of view, a theory cannot stand in a relation of mutual, exclusive correspondence with reality: it cannot literally “reflect” reality, because reality and theory belong to different categories. This means that the very idea of a reciprocal correspondence between theory and reality that presupposes an “outside view,” or a “God’s-eye view” (in Hilary Putnam’s phrase), is mistaken.

We interpret physical theory – and quantum theory in particular – as a Wittgensteinian rule (henceforth: a c-rule) (Pris 2014, 2018).²⁷ Quantum theory, like the rule of law, is “universal”: that is, like any rule, it has its own domain of applicability (of meaning), and is universal within that domain – but this domain is itself fixed in the course of the rule’s application, and does not presuppose any prior division between observer and observed. Quantum mechanics gives us a slice of reality; its effective application – that is, the actualization of the rule – is pragmatic and practical. The peculiarity of quantum mechanics is that, as a result of this actualization, the physical value obtained corresponds to only one term in the decomposition of the wave function in terms of the eigenfunctions of the operator for the physical quantity in question, not to the wave function as a whole – and it is precisely this that constitutes the connection between the mathematical apparatus of quantum mechanics and its physical interpretation.

The perspectival (contextual) view of a measurement result does not raise the further question of other possible measurement results, nor of comparing the actual result with them: the actualization (realization) of an observation is irreversible, and automatically excludes other realizations (their existence in “parallel worlds”). Comparison among different possible measurement results is made only from an external point of view, as a matter of theoretical reconstruction.²⁸

²⁷A similar interpretation is given in Bitbol 2015. Bitbol writes that quantum theory provides “rules for action, but not the slightest indication of what the action refers to” (Bitbol 2015: 387).

²⁸Unlike classical theory, quantum theory does not formalize the concept of an event at all. The event, on Bitbol’s view, is a performative event; in our terms, it refers to the application of a rule – that is, an “event” is the application of a rule. It is accordingly not predetermined: the rule does not apply to it from outside, but identifies it in context, within the language game.

Philosophy of physics often makes a mistake that, in our view, Wittgenstein diagnoses: the

(conceptual) representation of an event is conflated with reality (the real) – one is mistaken for the other. In classical mechanics, in particular, the objective event is the representation of an event, not a real event; but in classical mechanics, unlike quantum mechanics, this conflation has no serious consequences.

The Measurement Problem as a Pseudo-Problem (a Logical Problem)

As we can already conclude from the foregoing, the measurement problem in quantum mechanics is a pseudo-problem, one that owes its existence to the conflation of the categories of the real and the ideal. Let us examine this more closely.

We agree with Jocelyn Benoist that metaphysics conflates the categories of the real and the ideal (Benoist 2017, 2018b). Metaphysical realism, the epistemology of modernity, continental idealism (anti-realism, and postmodernism in particular), the semantic idealism of analytic philosophy, traditional phenomenology's treatment of the "phenomenon" as an autonomous given, and the residual idealisms found in the twenty-first century's so-called "new realisms," are all consequences of this same conflation. Contextual realism – a genuinely realist, critical approach – takes this distinction into account.

We will argue that the so-called measurement problem in the philosophy of quantum mechanics – a problem that will soon be nearly a century old – can likewise be solved by taking into account the categorical difference between the real and the ideal, in particular between a quantum system and a measuring instrument.

The starting point is to notice that, by definition, a quantum measurement performed with a macroscopic device is not a process of interaction between it and the microscopic quantum system: the stochastic, irreversible reduction of the wave function accordingly has no status as a physical process.

Let us begin with a few historical remarks showing that the difference between the logical and the real has, to some extent, already been taken into account – explicitly or implicitly – by philosophers and physicists alike.

According to Niels Bohr, the concept of cause is not applicable to the relation between an atomic object and a measuring instrument: it is impossible to say that the interaction between the device and the atomic quantum system is what causes what is observed on the device's screen, since only the causal relation between macroscopic

phenomena can be experimentally detected (Faye 1991).

Criticizing Kant, Schopenhauer writes:

Let us pass to another significant (grande) piece of realism, namely that the cause of our sensory perception is “external” objects. It suffers from the same defects as the foregoing. Numerous post-Kantian philosophers have already stressed that applying the Kantian category of causality to the relation between the thing in itself and our experience is entirely inappropriate, since this category is, by definition, applicable only within experience. The principle of reproduction, which is the rule governing the use of the category of causality, establishes only an objective relation between phenomena, not between these phenomena and something on the other side of them. (Schopenhauer 1966: 37.)

Hume holds that the realist projects immanent (semantic and epistemic) traits onto the transcendence of the “outer world,” and thereby reifies them. As a result of this projection, the regulative procedure of attestation is turned into an idea of truth as conformity, intersubjective agreement is turned into a single structure belonging to the outer world, and causality is turned into an intermediary between world and senses (Faye 1991: 207; Bitbol 1994). Bitbol also observes that it is possible to treat “fuzzy objects” or “incomplete objects” as projections of a merely epistemic indeterminacy.

Some “new ontologies” are, in fact, nothing but projections of theoretical structures. The interpretation of a quantum system’s wave function, within the framework of metaphysical realism (and classical logic), as literally reflecting the structure of the world, for instance, leads to a metaphysical picture involving a multitude of parallel universes. The hypostatization of intentionality (of a norm) leads, similarly, to the false idea that a red cap or a unicorn exists (in the sense of the corresponding field). For Markus Gabriel, everything exists except the world (Gabriel 2015).

With this in mind, one should distinguish between contextual realism, which identifies what exists by means of theoretical structures within contexts – structures that turn out to be internal to a given point of view – and projectivism, which projects theoretical structures onto an “outer world,” thereby imposing its own realities upon it.

Contextual realism rejects the dogmatic claim that an “outer world” exists. Markus

Gabriel goes even further, and claims that “the world does not exist” (Gabriel 2015). As Benoist points out, this denial should be understood as a categorical denial: reality is categorical, “world” is categorical. One can speak of the existence of real things within the world, but there is no point in speaking of the existence of reality, of “the world,” as such.

It seems to us, however, that the concept of *world* can be introduced as a concept of “form of life,” rather than as the totality of everything that exists (such a totality really would make no sense). We can accordingly speak of different worlds, of the formation of worlds and of their destruction (“globalization,” for instance, is nothing but the destruction of our world, or of our worlds – so that we may well ask ourselves whether our world, in this sense, still exists today).²⁹

The view of the measurement process in quantum mechanics as a process of interaction between instrument and physical system is a kind of projectivism: it places the normative (the rules according to which a measurement is made, and hence the measuring instrument *as* a measuring instrument) and the real (the quantum system) within one and the same category. This leads to an infinite regress: more and more new observers must be introduced, in order to observe the previous observers.

The regress stops once the categorical difference in question is taken into account. In fact, the subject who uses the instrument does not impose his point of view from outside (an “outside” view would mean classifying the measuring instrument and the system being measured within the same category); rather, the subject is already, within the context of the measurement, situated at the point of view of the measuring instrument itself.

Thus the reduction of the wave function is not a physical process. In particular, as noted above, although the specific correlated values within a quantum correlation are not predetermined, they are predetermined once a context is fixed. The measurement of a quantum correlation presupposes the choice of this or that context, a choice that, according to the laws of quantum mechanics, is probabilistic. The choice of context, however – that is, the application of quantum theory, within a given context, as a Wittgensteinian rule (norm) for measuring quantum phenomena (an application that can only occur within the context of the very phenomenon in question) – is, by definition, not something described, or describable, by the theory. The gap between theory and its application in context is logical, not substantial: it is closed as part of the language game of applying the Wittgensteinian rule that the theory constitutes.

²⁹Unlike Gabriel, Benoist does not reject the notion of world.

The measurement problem in the philosophy of quantum mechanics is thus a pseudo-problem, produced by the false presuppositions of a characteristically modern epistemology and metaphysics. Although our conclusion is negative – the problem does not exist – understanding *why* it does not exist allows us to see the error underlying most interpretations of quantum mechanics. Philosophy is not merely conceptual analysis: there is such a thing as progress, and an understanding of truth. But – to paraphrase the contemporary German philosopher Markus Gabriel – this progress lies not in deepening our problems but in clarifying them, in bringing to light what lay hidden behind speculative metaphysical pseudo-theorizing.

Let us illustrate the quantum measurement problem with the following example from Wittgenstein, which plays an important role in his later philosophy (see also the discussion of this example in Benoist 2018). Wittgenstein poses the question: “Isn’t it like this: before we can recognize something as being 2 m long by measuring it, must we first recognize something as being 1 m long by intuition?” (Wittgenstein 1993: 373). Wittgenstein’s answer is no.

A standard length – a metre, say – plays the role of a norm. By definition, the standard is used to measure length; this is sometimes accompanied by a feeling of “intuition,” but this does not mean that the standard itself is grasped by intuition, or applied by being compared, via intuition, to the object it measures.

How do we know that we are dealing with a standard (a norm) at all? We are always, from the outset, already within some context. The concept of context presupposes the concept of a norm that is implicit, or explicit, within it – that is, the standard is already implicit in any context in which it makes sense to speak of measurement at all; where it is not, there is no point in speaking of measurement. This is simply the logic of measurement and normativity.

To measure, in any sense, presupposes having a norm; and conversely, the existence of a norm presupposes a set of its well-established applications. We can, of course, measure the standard metre itself – if, say, we want to confirm that it really is one metre long – using a different standard (perhaps a more accurate one). But in that case the original standard is no longer functioning as the standard: its status has changed, and we are still left with the very same question about the length of *that* standard. The circle closes. Thus, if we persistently ask how we know that we are really applying the standard – that we really have a standard metre – an infinite regress results. The regress stops only if we grant that, when a given length functions as a standard, we do not know that it is one metre long in the same sense in which

we know that whatever is measured by it is this or that length – two metres, one metre, or whatever. “Knowing” that something functions as a length standard is logical knowledge, knowledge of a “logical fact.” It is also possession of the standard: knowledge of the norm, knowledge of how to apply the norm – that is, knowledge-how. The knowledge that something is two metres, or one metre, long, because it has been correctly measured as being two metres, or one metre, long, is actual (empirical) knowledge in its own right – knowledge-that. The first is logically reliable, “hinge” knowledge; this is what is meant to be revealed, in context, as a norm – typically a concept. The second is the result of applying a norm, rule, concept; its authenticity is the authenticity of the correct language game. Knowledge-how and knowledge-that do not exist without one another, but are two aspects of one and the same knowledge.

In other words, an infinite regress arises only if we want to be certain, so to speak, that what we are measuring really is one metre long. The trouble here is that we fail to distinguish the category of the real, to which what is measured belongs, from the category of the ideal, to which the standard of measurement itself belongs. Although the measuring device is itself material, the measurement confers on it an ideal status *as* a measuring device. (That is, the question of reality and ideality must be kept distinct from that of materiality and immateriality.) The measuring norm itself cannot be measured, because it is precisely what measurement is designed around.

To have a norm presupposes some sense that there is a standard of measurement – a feeling that is, so to speak, the “summons of reality,” one that underlies every phenomenon in which it manifests itself. The meaning of the length standard, as a length standard, lies in its use. That some wooden bar counts as a standard length is not something we are told by “intuition,” in Russell’s sense: there is no metaphysical standard of length located in some Platonic realm, and no metaphysical intuition to the effect that whatever is one metre long is one metre long. For the metaphysician, “it would be by intuition, as it were, that we should know – not that this or that piece of wood is one metre long, but that, in general, whatever is one metre long is one metre long” (Benoist 2018: 159). “Feelings” of the logical validity of the standard, and of the epistemic validity of the language game, replace the need to posit any “intuition” (see below). Without this “sense” of authenticity, measurement itself would not be possible.

Physics as an Exact Science (A Critique of Empiricism)

By analogy with our critique of “intuitive” knowledge of the length standard, Wittgenstein criticizes Russell’s view that “intuition” plays a role in applying words to real objects (Wittgenstein 1993). Bertrand Russell, opposing empiricism, holds that the use of words requires, in addition to the senses, a non-empirical intuition – “acquaintance” – needed to distinguish, for instance, between a hallucination of an object and the real object to which the word refers (Russell 1935–6). Thus, in Russell’s case, Platonism functions as an auxiliary tool that empiricism itself requires; Platonism, in other words, turns out to be the flip side of empiricism. This shows that empiricism rests on false presuppositions from the outset.

For Wittgenstein, words function as norms (concepts) that measure real objects directly in use, without the mediation of intuition. We use words and expressions, language within language games – actions – and forms of life, whose very presence already presupposes the simplest, paradigmatic (instinctive) cases of their application, cases in which words refer to real objects. A word does not exist apart from action (deed) – that is, apart from the totality of its applications; and conversely, any genuine action presupposes a logos (a norm) to which it submits and which can be expressed in words. So “in the beginning was the Word” means “in the beginning was the deed” (Wittgenstein refers here to this expression of Goethe’s). We agree with Benoist that, at a deeper level, word and action are one and the same (Benoist 2018: 161).

It is in action – within the framework of what we are doing, and not through non-empirical intuition (nor through empirical association, or memory, or anything else) – that words come to refer to real objects. Language is a system of norms; in its actual use it “measures” reality, identifying the things themselves in the context of real objects.

The basis of our knowledge, then, is not some primitive intellectual form of knowledge-that, but primitive forms of behavior – that is, forms of knowledge-how. In this sense, even primitive forms of behavior are normative: they are genuine language games.

The kind of knowledge just described applies to science, to scientific language, and to physical theories. It is sometimes said, for example, that in physics all statements, predictions, and measurements are probabilistic, not exact; that physics does not give us absolute knowledge, because it is an empirical science, and since we cannot perform an infinite number of experiments, we cannot rule out that some future experiment will refute a given physical theory. For Karl Popper, any genuine scientific physical theory is falsifiable – refutable by future experience. But those who press this argument fail to notice that it applies equally to everyday life; and yet in everyday life, we know a great deal.

In fact, within any context, within any established domain of physics – any “form of life” – and within any language game belonging to that form of life, there are limits of acceptable accuracy. Once those limits are met, what we have is not merely an opinion justified with some probability, but knowledge. That is, the criteria for knowledge – the rational grounds knowledge requires, and the degree of obviousness it requires – are themselves context-dependent.

Knowledge is true, justified opinion, provided “justified” does not mean fully, exhaustively justified (the well-known Gettier cases – “justified true beliefs that are not knowledge” – can be understood as cases in which full justification is lacking). Justification and probability are not concepts that simply track one another: in one case an opinion may count as knowledgeable, i.e. reasonable, while in another it may not, even where the probability of its truth is lower in the first case than in the second (see, e.g., Williamson 2014). On the other hand, we can also speak of more or less reliable knowledge – that is, there are criteria not only for knowledge as such, but for degrees of reliability within knowledge.

Where the relevant limits of accuracy are not met, by contrast, one cannot speak of knowledge at all, but only of the probability that an opinion is true. Consider the discovery of the Higgs boson: we know that it exists – we do not merely have a reasonable degree of confidence that it exists – because the statistical significance of the experiment in which it was found reached five sigma or better, the threshold conventionally required, in particle physics, for a result to count as a discovery. When the significance was below five sigma, all that could properly be said was that the Higgs boson’s existence was likely – a hypothesis – not that its existence was known. A justified opinion, even a true one, is not always knowledge.

Quantum Causality

From Wittgenstein's point of view, it is possible to speak of causes and effects only because, in certain basic situations (language games) – our most primitive interactions with the surrounding environment – we already interpret some of the things around us as “causes” of what happens, and not merely as accompanying what happens; we are able to identify certain causes and effects, that is, to master the corresponding concepts. In other words, our language, which employs the concept of cause, arises out of primitive, “instinctive” causal reactions. These latter are themselves genuine language games, ones that already possess a normative dimension and already carry causal meaning. A causal language cannot be reduced to some further, unjustifiable ground: we cannot identify causes by starting from a position in which it is wholly unclear to us whether they exist at all, or what they are. The primitive language games are authentic; in this sense they form the very basis of our language and its use.

Indeed, what has just been said expresses the very nature, the logic, of language – not some further positive property of it.

In other words, causes, effects, and cause-and-effect processes do not exist in the “outside world” as such. At the level of bare, unstructured reactions there are no specific causes or effects; an instinctive response becomes a causal relation only once we are able to deploy the concepts of cause and effect. From the standpoint of the logic of language, “causes” are not objects: they are not simply given.

For Wittgenstein, the concepts of cause and effect are defined within their actual use – that is, within the corresponding language game involving “causal experiences.” The latter accordingly make sense only within the causal language game: they accompany it. Thus Benoist writes that the status of “causal experimentation” is analytic: “It is all right to call them ‘experiences of the cause,’ but this is analytic – they are such because the language game of cause and effect is built on such experiences” (Benoist 2018).

Jocelyn Benoist writes:

The fact that my hand does not hurt anymore when I remove it from the flame does not by itself mean that this flame is the “cause” of my pain. We are back to the main point: it seems that “the cause,” as such, is not given. To call it a cause is always already to exceed the limits of the given: to place it in a logical space. However, when we ‘look out for a reason,’ we already do that: we look out for something that is not a mere concomitant but that we want to be able to take for the real reason of what we wish to change or to control. If it is not possible to take it this way, i.e., to take it that it is truly the cause, there is no ‘cause.’ ‘Cause,’ essentially, is ‘the true cause.’ Now, this possibility essentially presupposes language and this capacity that it saddles us with, to take some distance from the given. (Benoist 2018: 162–163.)

Wittgenstein’s “primitivism” consists in the thesis that a language game is grounded in something “instinctual”: “In its most primitive form it is a reaction to somebody’s cries and gestures, a reaction of sympathy or something of the sort. We comfort him, try to help him” (Wittgenstein 1993: 381). These are basic human reactions; they are, so to speak, the standard. We are able to reason in causal terms precisely because we possess this kind of normative experience.

So, before we can meaningfully speak of causes and effects at all – before we can even raise the doubt whether some particular thing we take to be a cause really is one – we must, in certain established cases, already be sure that certain things are the causes of certain events. In other words, (certain) causes exist only within the framework of a causal form of life – that is, within the form of life in which this or that concept of cause has been developed. Like other language games, causal language games are established through success; reliability and success come first, doubt is secondary.

Since the concept of cause becomes meaningful only within a language game, and language games differ across different regions of reality, the concept of cause is accordingly not univocal. It makes no sense, for example, to argue about the cause of quantum correlation using a concept of causality borrowed from everyday life or from classical mechanics; a quantum causal language game must instead draw on quantum theory itself.

Traditionally, to explain something is to find its cause. The cause of a phenomenon, in a generalized sense, can be understood as its logic – a rule that allows the phenomenon to be reconstructed, justifying it post factum. It seems to us that such a reason (rule) can also be regarded as the best explanation of the phenomenon.

As is well known, the “inference to the best explanation” principle holds that, among all possible explanations, the best one should be chosen. An explanation that is not, in fact, true, however, cannot be the best one. This means that the principle presupposes a realist position – but the realism thereby presupposed is metaphysical: it assumes that there already exists a predetermined reality of which the explanation is either true or false, and that the best explanation is the one that is true, that explains this reality correctly.

Understood this way, the principle runs into the problem of its own justification. We can never be sure that the “best” explanation really is the best: “external reality” might always turn out to differ from what we assume, the choice of best explanation is always, in a sense, a guess, and we can never be certain that we have guessed correctly. What we are dealing with here, it seems to us, is simply another instance of the epistemological “problem of access” to external reality that confronts modern philosophy.

In fact, “best explanation” admits of a different reading: not as an explanation of some predetermined metaphysical reality, but as the articulation of a rule, a “grammar” (not predetermined), of a non-metaphysical reality, within a language game or context (Pris 2008). On this reading, the correct application of the rule just is the “best explanation” of the corresponding phenomenon, since, within the framework of the phenomenon, it identifies the real object; the gap between the two is logical, and closes in practice.

That is, something is real not because it is postulated to be the best explanation, but rather because it is grounded in reality and thereby identifies the real object: reality is primary, explanation secondary, not the other way around. Thus laying bare the general grammatical rules, and specifying the (substantial) conceptual scheme of a phenomenon – its description, or “representation” – is, at the same time, laying bare its cause in the generalized sense: the notions of explanation and description converge on the same concept.

This is why it seems to us that what Bitbol calls the entangled wave function (Bitbol 2015) can be understood as the cause, in this generalized sense, of quantum correla-

tion: it is precisely this quantum language that allows us to speak of a cause at all. Where there is no entanglement of the wave functions of the two systems, there is no correlation.

The quantum correlation is explained by the evolution of the wave function, governed by the Schrödinger equation. Quantum causality, unlike classical causality, is “not autonomous and categorical, but conditional and participatory” (Bitbol 2015: 336): that is, the existence of causality here presupposes the existence of a subject applying a theory, concepts – a subject participating in practice. In fact, as noted above, this holds even in the most ordinary cases.

Quantum Correlations

Quantum correlation consists in the fact that, when we measure the value of an observable for one particle, we thereby know that another particle, entangled with it and located as far away as one likes, will have a determinate value of that same observable – even though, prior to measurement, neither particle had any determinate value of the observable at all.

The notion of the collapse of the wave function presupposes metaphysical realism, and leads, in the case of quantum correlation, to an unacceptable notion of action at a distance (quantum correlation is also known as the EPR, or Einstein–Podolsky–Rosen, effect; Einstein 1935): at least, matters look as though there were a long-range action, as though the collapse of one particle’s wave function instantaneously affects the collapse of the other’s.

Both Einstein and Schrödinger opposed the notion of the reduction of the wave function as a substantial “collapse” (Schrödinger 1935, 1936). As part of his interpretation, which tries to steer a middle course between the positions of Bohr and Einstein, Everett dispenses with collapse altogether (Everett 1957).³⁰ Others have proposed doing without the concepts of the collapse of a wave function and of the quantum system altogether, and dispensing, too, with the metaphysics of particles and action at a distance, in favor of redefining the concept of entanglement (see, e.g., de Ronde 2018b).

Our contextual point of view can be summarized as follows. Measurement simply identifies, within a fragmented reality, a determinate context in which both particles have certain (mutually correlated) values (for instance, two electrons may have spin projections on the z axis of $+\frac{1}{2}$ and $-\frac{1}{2}$, respectively). Different measurement

³⁰Note that Everett quotes Einstein as saying that he could not believe that a mouse could bring about drastic changes in the universe simply by looking at it (Everett 1957, Dissertation: 116). Schrödinger, for his part, writes: “But jokes apart, I shall not waste the time by tritely ridiculing the attitude that the state vector (or wave function) undergoes an abrupt change, when ‘I’ choose to inspect a registering tape.”

outcomes correspond to different contexts. The transition from one context to another is not any kind of substantial transformation of context; “context” here simply means that the interaction between observer and observed system – better called “contact” – is non-perturbing. Otherwise we would not be talking about measuring the system at all, but about measuring the interaction of two systems. Such an “interactivism” would amount to a form of correlationism, on which we would have access only to the correlation between observer and observable, and not to the observer and the observable as such.

Let us examine the proposed view in more detail. Observing a quantum correlation between physical quantities presupposes the prior preparation of an entangled situation of wave functions, together with the use of quantum language (a pragmatic moment) and the practice of applying quantum theory. These conditions, in fact, are necessary for the very existence of a given quantum correlation: taken by itself, independently of the use of the theory and prior to it – that is, prior to the moment at which the correlation is identified in the language of quantum theory – the correlation does not exist as a determinate object in the “outer world”; it is not predetermined.

In the general case, from the standpoint of contextual realism, we hold that, within quantum mechanics, it makes no sense to speak of determinate events (events as such) prior to their identification by means of quantum theory. From the standpoint of everyday life, it is assumed that an event first occurs, and is only subsequently formulated as a fact with the help of language; the “event” is thereby, in effect, absolutized, taken out of context. In fact, an event exists only as a determinate given, one identified within a “language game” – to use Wittgenstein’s terminology – within the use of a language, such as that of physical theory.

Let us turn, then, to quantum correlation itself. It is well known that the results of simultaneous (or non-simultaneous) measurements of some physical quantity, performed on two entangled systems however far removed from each other in space, are correlated (for example, measurements always yield the same, or opposite, values for the spin projection on the z axis). If one supposes – as one would within the bounds of classical physics – that what is at issue is a correlation between two events arising in an “external world,” then explaining the correlation requires either positing a long-range interaction, propagated at a speed exceeding that of light, even instantaneously (though it is easy to show that the correlation itself cannot be used to transmit information faster than light), or positing some general, material common cause responsible for the two correlated events’ behaving as they do, a common, non-local influence acting on both.

At the same time, the explanation can be regarded as non-local in the sense that it is holistic: the correlation, on this view, is not explained but simply accepted, as an effect of the system as a whole – an “action” rejected by most physicists. As for a causal correlation understood by analogy with a classical correlation, its existence would be equivalent, in quantum mechanics, to the existence of hidden variables.

In 1964 Bell showed that quantum correlations resulting from the entanglement of quantum states cannot be understood within a theory of hidden local variables: this meant that “local realism” – the predetermination of the properties of quantum objects by local hidden parameters – is untenable. In 1981 Bell further showed that quantum mechanics excludes the joint tenability of the reality of experimental events (understood as a predetermined reality) and their locality. “Realism” – that is, the reality, understood as predetermined, of experimental events – is accordingly rejected by Bitbol as well (Bitbol 2015; see also his 1983 article).

At first glance this can look like a radical anti-realism, since even a merely empirical (minimal) realism is thereby rejected. But from our contextual point of view, a quantum event – like a quantum object endowed with certain properties – is real without being predetermined (only metaphysical realism treats it as predetermined, meaningful in itself).³¹ Within contextual realism, ontology is contextual, and this applies equally to the ontology of events.

We can put the point about quantum correlation this way. In fact, as a result of the entanglement of two systems (their wave functions – spin states, say), a single system emerges; it is accordingly impossible to speak of two independent subsystems (two independent physical variables, components of a common wave function). This means that a measurement performed on one “subsystem” is, at the same time, a measurement performed on the whole system, and hence also on the second “subsystem.” By definition, by the very meaning of the entangled wave function, the outcome of a measurement performed on one “subsystem” fixes the outcome that can be obtained, at the same time or later, on the other subsystem. There are not, properly speaking, two “events” here, but a single measurement performed on the whole system. Strictly speaking, then, the language of “correlation” is not quite appropriate here – or, if we retain it, we should not speak of a correlation *between two events* (as though they were events belonging to the “outer world”), but of a

³¹The classical metaphysical (acontextual) approach to the event is already found in Wittgenstein’s *Tractatus*: a sentence, there, is an image (picture) of reality (§ 4.01); propositions *show* the logical form of reality (§ 4.121). In the case of an event, this would mean that the statement expressing a fact is the image of the event that precedes that statement.

correlation between two measurement *results*.

Nor should this explanation be described as recognizing a long-range non-locality, since what is at issue is a single, integral system rather than two systems exerting a (non-local) influence on one another. At the same time, the explanation can also be regarded as non-local in the sense that it is holistic. In fact, on this view, the correlation is not explained, but accepted as an effect of the system as a whole. Let us try to explain quantum correlation, then, from the standpoint of contextual realism.

Let us recall that we treat theory – quantum theory in particular – as a Wittgensteinian rule: a conceptual scheme rooted in the reality of its applications (so that, although we speak of applying the theory as a rule that allows us to make predictions, our position is not instrumentalism but a form of realism; Pris 2012). Quantum theory tends to “describe,” “explain,” and predict phenomena, in a generalized sense of these terms.

Wittgenstein (see *Nachlass*, Manuscript 160) points to the existence of two kinds of rules, differing “grammatically” – that is, logically, in a broad sense: the rules of chess belong to the first kind, the rules of cooking to the second. Nothing in reality corresponds to the rules of chess: they do not reflect the nature of chess pieces – which have no nature independent of them – do not describe the game of chess, but rather constitute it. In this sense such rules have no “nature” of their own. The rules of cooking and roasting, by contrast, “must be appropriate to the nature of the meat”; they have real conditions of eating, without which the point of cooking would not be achieved (see the quotation and discussion in Benoist 2017: 129). The reality in which such rules are rooted imposes constraints on their choice; though the correspondence at issue here is not a mutual correspondence between wording and “external reality,” not an isomorphism. In a generalized sense, nonetheless, one can say that such rules “reflect,” or describe, the nature of the food.

In terms of the familiar distinction between knowing-that and knowing-how, knowing the rules of chess, or the rules of cooking, is knowledge-how (knowing how to play chess, or how to cook) – practical knowledge. Since what is at issue is “knowing” rules, we might also call this “grammatical knowledge” within the practical domain. Wittgenstein reserves the term “grammatical” knowledge, properly speaking, for cases such as the knowledge that one and the same surface cannot, at the same time, have different colors; at the same time, he gives the notion of “grammar” a literal meaning (thereby revealing its true essence through such examples).

Grammar, for Wittgenstein, is “autonomous,” and marks out the limits of the meaningful use of language. Its autonomy does not mean that it is detached from reality; on the contrary, it implies that paradigmatic cases of its real “realizations” have already been built into it: the network of real language, of words and notions, is such that the use of the sentence “this part of the surface is simultaneously red and green,” or of the expression “greenish-red,” is prohibited – is nonsense. This nonsense is not constituted at the level of semantics – of the meaning of the concepts involved – but, on the contrary, the meaning of those concepts is itself established on the basis of a prior syntax (“meaning is use”). Nonsense here is the very same kind of nonsense as the nonsense of an ill-formed string like “green or” – there are no fundamentally different *kinds* of nonsense. Nonsense is a violation of the rules. (Nonsense should be distinguished from the incorrect application of a rule: the meaningless application of a rule outside its domain of applicability is likewise nonsense, though such nonsense amounts to breaking the rules themselves.)

The exercise of practical knowledge is itself a kind of action. The correct application of a grammar is an intentional action – with a “fulfilled” intention, if we take up the concept of the fulfillment of an intention introduced by Edmund Husserl and interpret it, in the spirit of the second Wittgenstein’s philosophy, as the satisfaction of a norm/rule (intentionality here plays the role of the norm; Benoist 2017). Action, in this sense, is akin to knowledge – that is, to knowledge-how (Williamson 2017, “Acting on Knowledge”).

(Theoretical) knowledge, which likewise presupposes knowledge of grammatical rules – that is, knowledge of how to use them – is knowledge-how. The distinction between practical knowledge-how and theoretical knowledge-how is not, in this sense, a crucial one: in one case we are dealing with a practical grammar, in the other with a theoretical grammar. The rules for roasting meat belong to a practical “grammar,” while the epistemic norms governing knowledge in a given context belong to a theoretical grammar.

On this basis, further, unless a distinction is expressly drawn, we can simply speak of Wittgensteinian grammar without distinguishing between its theoretical and practical domains.

It is precisely the rules rooted in reality – the rules of cooking, say, or context-dependent epistemic or linguistic rules, i.e., rules that incorporate elements of reality – that Wittgenstein calls “grammatical rules”; these possess a relative autonomy, unlike purely instrumental rules detached from reality. Purely functional rules, like

the rules of chess, can be regarded as a limiting case.

All this applies equally to understanding quantum mechanics as a Wittgensteinian rule (henceforth: a c-rule) – a quantum Wittgensteinian grammar (Pris 2014). The rules of quantum theory, including, in particular, the concept of the wave function, correspond, in a generalized sense, to the nature of quantum reality – a reality that is not a metaphysical, object-like reality located “opposite” the description given by quantum theory.

Quantum theory is knowledge-how – possession of a right, or entitlement – to a greater extent than, say, classical mechanics, which in a certain sense does literally reflect “external reality.” The entangled wave function that allows us to describe the well-known EPR paradox (quantum correlation), for instance, does not literally reflect an external reality (though it is sometimes so described, and said not to be real in that sense); rather, there is a rule, rooted in reality, for carrying out a real experiment and for predicting its real, probabilistic (and, in general, only probabilistic) results within known bounds (as, for example, in many-worlds interpretations). But we cannot say that it fully constitutes the results of quantum measurements.

As noted above, grammar, for Wittgenstein, is “autonomous”: its autonomy is a logical autonomy, the autonomy of a norm. In the case of physical theories, this autonomy is expressed in our interpretation of physical theory as a Wittgensteinian rule (a c-rule; Pris 2014). It should be stressed that the rootedness of “grammar”/theory in reality not only fails to limit its autonomy, but is, on the contrary, its very condition – a condition both of its comprehensibility, of its resistance to insignificant empirical data that ought to be disregarded, and of the possibility of genuinely new applications and predictions. There is no such thing as absolute autonomy: all genuine autonomy is rooted in reality.

This autonomy is expressed in Einstein’s remark that what is real is determined by physical theory. This does not mean that theory constructs reality; it means, rather, that theory fixes reality in the sense that, on the one hand, it logically incorporates the reality of its own paradigmatic applications (this is the well-known requirement of “unity of judgment” to which Wittgenstein refers) and, on the other hand, identifies new dimensions, new slices of reality, as reality described or explained by the theory (it seems to us, in the spirit of Wittgenstein’s philosophy, that the difference between description and explanation can, in this sense, be dissolved). In addition, as noted above, there is always some empirical “residue” that must be disregarded.

The foregoing applies equally to the concept of an event. If by “event” we mean simply a fragment of reality (outside the application of quantum theory), it has no identity (indeed, strictly speaking, there is no event at all). If an “event” does have an identity, that identity cannot be absolute, predetermined, decontextualized: it presupposes the use of quantum language (though this does not mean that such use *creates* the event, the reality in question).

Our contextual view, then, is that a given event is identified from within a certain point of view, as the result of applying concepts, a theory. The idea that an event occurs prior to its theoretical description is mistaken. The question of the event’s persistence (or non-locality) simply does not arise, for it could arise only if the concept of an event were such that the event were taken to exist regardless of the means of its identification (language, quantum theory, the concept of the wave function, and so on). “Correlation” is a decontextualized comparison between two measurements, made by different observers, in different contexts, after the fact. It is itself a point of view: there is no context in which the correlation itself, as such, is observed. What physicists call “correlation” is thus not a correlation between certain absolute events, but a correlation between measurements, or between events considered as measurements.

We therefore regard every phenomenon as contextual, rooted in reality. In particular, we take quantum correlation to be the contextual identification of a certain slice of reality, one fixed by quantum rules.³²

³²The semantic choices made by non-communicating speakers across multiple discursive contexts can be correlated in accordance with the law of quantum correlation; this illustrates the contextual nature of such correlations (see, for further detail, Bitbol 2019: 219). For Bitbol, contextuality is what relativity, or “correlation,” of determinations amounts to (Bitbol 2019: 261–262).

Bitbol rejects a realist epistemology in favor of one of “correlating.” For him physical quantities are relative; their relativity becomes visible across periods of scientific revolution. During the “normal” development of science, as a kind of amnesia sets in, physical quantities are absolutized; Bitbol holds that, as science develops, the objects and properties introduced at an earlier stage are replaced by trans-relational invariants. This is a neo-Kantian approach, on which only relations are objective, and only laws, not objects, are identified through experience (Cassirer 2000).

Like Bitbol, we are contextualists, yet our position remains realist. The relative value can be treated as a conventional value; it can, however, also point to some more general, absolute value – a relation, a structure. From our point of view it can equally be interpreted as an absolute value within its context. That is, the very nature of a physical quantity depends on the point of view: for us there are both absolute values (objects, properties) and relative

ones (relations, structures), which can each change character. All values are contextual, not autonomous. “Absoluteness” is rejected only in the sense of “autonomy,” independent of context. In special relativity, for example, in terms of absolute four-dimensional intervals and tensors, four-dimensional coordinates are not absolute but depend on the reference frame; at the same time, within each fixed reference frame, considered not as an external point of view on four-dimensional invariants but as a context, an internal point of view – a method of identification, coordinates and time become absolute physical quantities.

Our position can be seen as a contextual interpretation of Kit Fine’s “fragmentalism” (Fine 2005: 46). From Fine’s point of view, “special relativity shows not that Newton’s idea of space-time is mistaken, but that the idea that there is only one space-time is mistaken”; he speaks of “a plurality of physical spaces, each with a Newtonian structure.”

The First-Person Point of View in Physics

Bohr raises the question whether quantum mechanics describes experience in a comprehensive way (Bohr 1961). Indeed, the evolution of the wave function, as described by the Schrödinger equation, is not by itself sufficient to explain the occurrence of a particular event; Bohr accordingly supplements it with a space-time description of the quantum event that occurs at the moment of measurement. In fact, no theory can describe experience in a fully comprehensive way: experience is real, and theory is ideal. Experience is not described by theory; it is built into its use, which is always perspectival. The subject who applies the theory is himself part of the physical phenomenon the theory describes. Such a position, however, is not subjectivism, since introducing the subject means only taking into account the fact that any phenomenon presupposes some internal perspective. In this sense one can understand Bohr's reproach to Einstein: that the latter fails to take into account the lesson of his own theory of relativity, and preaches instead the idea of a detached observer (Bohr 1961; see also the discussion of Bohr in Fuchs 2018). In quantum mechanics, the observer is not detached from the phenomenon he observes.

The need to take the first-person point of view into account, not only in quantum mechanics but in physics generally, follows from a consideration of the nature of language.

Like the words and expressions of ordinary language, mathematical and physical terms, expressions, and theories are used in context. This allows us to describe an infinite variety of real things (ordinary, mathematical, or physical), to express an infinite number of different truths, and to anticipate and predict new phenomena. That is, words, terms, expressions, and theories have no fixed (absolute) referents. This is what Wittgenstein means when he writes:

The views of contemporary physicists (such as Eddington) are quite consistent with mine when they say that in their equations the signs no longer have any meaning, and that physics cannot arrive at such

meanings, but must remain at the level of signs. (Wittgenstein, *Philosophical Remarks*, § 225; cited in Bitbol 2018, “The Mathematical Demonstration.”)

According to Bitbol, Wittgenstein warns against the temptation to treat mathematical sentences as referring to “facts” of some special kind, or mathematical symbols as designating objects of a Platonic world; Bitbol extends this warning to physics and its own ontological claims. For Wittgenstein, we agree, signs (symbols) appearing in physical and mathematical theories have no transcendental – that is, absolute, context-independent – referents (Bitbol 2018).

At the same time, Wittgenstein enters a reservation: “To tell the truth, [contemporary physicists] do not see that these signs have a meaning insofar as ... the observed phenomenon immediately corresponds, or fails to correspond, to them” (Wittgenstein, *Philosophical Remarks*, § 225; cited in Bitbol 2018). Thus, for Wittgenstein, mathematical and physical symbols nevertheless have sense. On our reading, a “phenomenon,” for Wittgenstein, is a language game – that is, the use of a rule/norm (a theory) in context, in reality. Within the real thing, when the norm is applied correctly, the real thing itself is identified: in this sense, truth is conformity (to a real thing, a real fact), and “meaning (reference) is use.” A “phenomenon,” in this sense, is not something superficial – mere appearance, sensory data, or the like. That is why Wittgenstein writes: “the phenomenon is not the symptom of something else, it *is* the reality” (Wittgenstein, *Remarques philosophiques*: 270; cited in Bitbol 2018).

Wittgenstein’s claim about the “reality” of phenomena should thus be understood, not in the sense of a phenomenology that absolutizes the phenomenon as something autonomous, but in the sense that phenomena are rooted in reality: within the framework of phenomena, real things themselves are given. Bitbol interprets Wittgenstein’s remark, so understood, as “an immanentist thesis,” and holds, further, that Wittgenstein attributes this “thesis” to Bohr and to other physicists of the early 1930s, along with a relatively symbolic, non-referential formalism for quantum theory (Bitbol 2018).

Bitbol thinks that Wittgenstein drew only half the consequences of quantum mechanics. He points out that even “the bare matter of the phenomenon” is not independent of “the theoretical project of investigation embodied in the instrument that defines, and co-constitutes, the phenomenon.”

Perhaps, as Bitbol suggests, the phenomenon can indeed be said to be co-constituted

by a theoretical project. It cannot, however, be said that a thing (an object) is co-constituted *within* the phenomenon. A thing given within the framework of a phenomenon is not conceived, even in part, by the theory: it carries no “theoretical load,” but is simply identified in its own certainty.

The phenomenon is a conceptualized experience – the application of norms to the Perceptible. Insofar as it is conceptualized, it is theoretically, conceptually, loaded; but experience as such – experience itself – does not carry a theoretical load, has no theoretical (conceptual) component of its own (see also Benoist 2013, *Le bruit du sensible*).

Within a conceptualized experience – a phenomenon, or language game – it is possible to identify not only the object but also a particular type of experience, or even a singular experience. Of such an experience considered *as* a “language game” (and not as experience as such – experience as a fragment of reality) we cannot say that it carries a theoretical load, that it is co-constituted by concepts. It is simply identified by means of (phenomenal or theoretical) concepts, within the framework of a theory. Physical experimental data, in particular, are simply what they are; they carry no theoretical load, though their determinacy is possible only within the framework of a theory.

The phenomenon does not exist by itself: it exists only within the framework of a theory and its practical application by a subject. In this sense, theory and subject “produce” the phenomenon – though this does not mean that we cannot take given (determinate) things and experiences simply as they are.

Bitbol also holds that Wittgenstein draws a significant distinction between physical signs and mathematical signs, arguing that the former, at least, make sense – a sense that connects them to phenomena.

Bitbol himself claims that the parallel between mathematics and physics runs deeper than even Wittgenstein takes it to: “Just as, in mathematics, a proposition has no meaning independent of the demonstration that leads to it, so too, in physics, a factual statement has no meaning independent of its formal, instrumental, and performative context” (Bitbol 2018).

We agree that there is a parallel between mathematics and physics, and between mathematical and physical statements. But, in our view, this parallel is precisely the one Wittgenstein himself draws. A mathematical statement is deduced a priori within

the framework of a mathematical “form of life”; a true mathematical statement is one deductively established within that form of life. Physical statements and phenomena, similarly, presuppose a physical “form of life”; their truth is established, proved, with the help of physical theory together with experience – the two working in tandem, and complementing one another. The difference in the nature of the two kinds of statement lies elsewhere: in one case we are dealing with mathematical norms, in the other with physical norms; in one case with mathematical “language games” – applications of mathematical norms – and in the other with physical language games – applications of physical norms. In both cases, the statements in question, and their truth, depend on context. By themselves, out of context – out of their proof, in the mathematical case – they do not, strictly speaking, make sense, and lack a referent.

It is usually thought that physics is an objective science, describing nature from a third-person point of view, in terms of laws that are necessary and objective. Newton’s mechanics describes and predicts the motion of planets independently of any observer. In the *Philosophical Investigations*, Wittgenstein notes that in physics we do not use personal or indexical pronouns – to do so would involve the direct participation of the subject. In quantum mechanics, however, the concept of the observer plays an essential role, one internal to the theory itself. The first-person point of view, as Fuchs writes, traces back to the Copenhagen interpretation of Bohr and Heisenberg and Pauli, to John Wheeler’s point of view, to the informational interpretation of quantum mechanics due to Anton Zeilinger and Časlav Brukner, to Carlo Rovelli’s relational interpretation, and to the quantum Bayesianism (QBism) of David Mermin, Rüdiger Schack, and Christopher Fuchs.

Fuchs draws together a set of interpretations of quantum mechanics that introduce the first person – the subject, or observer – under the common name “participatory realism.” This is not a form of instrumentalism (anti-realism), but a new realism, one that generalizes the traditional notion of physical reality (Fuchs, “On Participatory Realism”).

In some respects Fuchs’s position is close to the anti-Kantian position of Einstein, and to that of the later Wittgenstein:

The theoretical attitude here advocated is distinct from that of Kant only by the fact that we do not conceive of the “categories” as unalterable (conditioned by the nature of the understanding) but as (in the logical sense) free conventions. They appear to be a priori only insofar as thinking without the positing of categories and concepts in

general would be impossible, as it is impossible to breathe in a vacuum.
(Einstein, quoted in Fuchs, “On Participatory Realism.”)

This view also resembles our own view of “categories” (and “concepts”) as Wittgensteinian “hinge propositions” – concepts likewise rooted in reality, in experience – which are similarly logical in character.

What is at issue is a pragmatic perspective. This perspective on quantum mechanics is developed in a book by Chiribella (Chiribella 2016). On the “dynamicist” perspective, one describes the behavior of systems in the outer world without mentioning the observer (the subject), and treats laws as necessary, objective laws of nature. Within a pragmatic perspective, by contrast, the subject becomes part of the theory, and physical laws are what allow the subject to control physical systems (Chiribella 2016: 2).

The pragmatic perspective runs deeper still: it applies equally within classical physics. Chiribella and Spekkens give the following example from thermodynamics (Chiribella 2016: 2). In Clausius’s dynamic formulation, heat cannot flow from a cold body to a warmer one, such that no other change results from this process. In the Kelvin–Planck pragmatic formulation, it is impossible to build a cyclic device whose sole effect would be to convert a quantity of thermal energy drawn from a single heat reservoir into an equivalent quantity of mechanical work.

Schrödinger’s wave mechanics is presented in the traditional “dynamicist” form (the wave function “describes”/“presents” the state of an evolving quantum system), while Heisenberg’s matrix mechanics is presented in an operational form, in terms of operators for physical quantities (Chiribella 2016: 2). The fact that these two formulations are equivalent means that quantum theory should not be interpreted either in terms of metaphysical realism or in terms of instrumentalism (anti-realism). The best view of it is contextual realism (on which ontology is contextual, identified with the help of instrument and theory together) – a view that is, in fact, indistinguishable from a contextual instrumentalism (on which instrument and theory, rooted in reality, likewise identify the ontology). What matters here is the notion of a theory rooted in experience, in practice, in reality – that is, the overcoming of the “gap” between the theoretical (normative) and the practical (the real). Understanding that this rootedness closes the gap logically allows us to dissolve many of the philosophical problems of quantum mechanics, and of physics as a whole.

Understanding the first-person point of view in physics also requires understanding

the irreversibility of time as a pragmatic precondition.

The emergence of a new language game, in a given context, is by definition not predetermined – which implies the possibility of “free choice.” When we apply a rule, i.e. become a participant in a language game, we perform an action, and thereby pass from the theoretical to the practical sphere; this means, by definition, that the reverse transition is impossible. In other words, a language game (an action) is irreversible. An action, if it is genuinely an action – that is, if it is intentional – is by definition free. It is thus natural, as Michel Bitbol does, to understand the irreversibility of time by analogy with the way freedom is understood. Kant understands freedom as follows:

(...) Every creature that cannot act except in accordance with the idea of freedom is, for that very reason, in a practical respect, truly free – that is, all those laws that are inseparably bound up with an inner freedom hold for it just as though its will had been pronounced free in itself, and in valid theoretical philosophy as well. I maintain, therefore, that we must attribute the idea of freedom to every rational being possessed of a will, and that it acts only under this idea. (Kant, Groundwork of the Metaphysics of Morals.)

Freedom, therefore, is not a metaphysical concept but a precondition for action: the concept of freedom belongs to the logic of action. By definition, we cannot act unless we are free; the presence of free will accordingly does not conflict with a deterministic theory of the motion of the human body.

Similarly, the universality of a symmetric (reversible) theory, such as quantum theory, is compatible with the pragmatic precondition of the irreversibility of time. Alongside our theories, we also have our practices, our actions, which carry their own pragmatic background. Bitbol treats the irreversibility of time as just such a pragmatic precondition. He proposes the following analogue of Kant’s argument, cast in terms of irreversible time:

Let us give the equivalent of this proposition for the case of irreversibility: any human community that can only communicate under the condition of an asymmetry between fact and prediction is, by that very fact, from a pragmatic point of view, genuinely immersed in a temporally asymmetric universe – that is, all the laws that are inseparably bound

up with a temporal asymmetry hold for it in exactly the same way as if its functioning had itself been recognized as asymmetric, for reasons valid with respect to a physical theory of elementary processes. (Bitbol 2015: 374.)

Thus the asymmetry of time (its irreversibility) is a pragmatic precondition. Communication is possible only if an asymmetry between prediction and fact is accepted, which itself implies an asymmetry of time. The functioning of time-symmetric laws thus appears as though the laws actually in force were performatively asymmetric in time. Bitbol shows, in his book, the logical compatibility of the theoretical symmetry of physical laws with their pragmatic and practical asymmetry (Bitbol 2015).

Contextual Realism and Modalities

In the *Critique of the Power of Judgment*, Kant assumes a dual nature for the human mind: sensible and intellectual. He writes (Kant, *Critique of the Power of Judgment*, § 76):

It is certainly necessary for the human mind to distinguish between the possibility and the actuality of things. The ground for this lies in the subject and in the nature of its cognitive faculties. For if the exercise of these faculties did not require two quite heterogeneous elements, understanding for concepts and sensible intuition for the objects corresponding to them, there would be no such distinction (between the possible and the actual).

On this basis, the main points of Kant's position follow: (1) a dichotomy between the actual and the possible; (2) the actual pertains to sensible intuition, the possible to the understanding; (3) both are arrived at by a limiting transition: the actual, by a transition toward the infra-human; the possible, by a transition toward the superhuman (see the discussion in Bitbol 2015: 19).

This assumption is not itself the outcome of Kant's philosophical analysis. In addition, as Bitbol notes, Kant upsets the balance between the sensible and the intellectual (the spontaneous), giving priority to the latter: for him, all possibilities coexist, and are relevant, within the intellectual space of God (Bitbol 2015, ch. 1). Kant writes (Kant, *Critique of the Power of Judgment*, § 76):

Indeed, if our understanding were intuitive, it would have no objects except what is actual. Concepts (which pertain merely to the possibility of an object) and sensible intuitions (which give us something without thereby letting us cognize it as an object) would both disappear.

All our distinctions between the merely possible and the actual rest on the fact that the former signifies only the positing of the representation of a thing with respect to our concept, and, more generally, our faculty of thought, while the latter signifies the positing of the thing in itself, apart from this concept.

For Kant, the division between the actual and the possible is overcome either through the complete intellectual actualization of every possible representation of a thing, or through the emergence of possibilities out of a pure receptivity that contains no conceptuality, no understanding, not even an intuitive one – something made possible only by time.³³

There are two ways of tracing out Kant's modal capacities: a deductive way and a genetic way.

A forward-looking view, one that analyzes possibilities – what *can* be – treats a rule as explicit, as something to which an event is subject, and evaluates its possible applications. In Kant's case, these possibilities appear to sit alongside one another within an intellectual space, rather than following one after another, as they do on a retrospective view. The rule, on this reading, points, so to speak, toward the eternal: it is a perfect norm. But, in fact, it cannot be detached from its specific applications; it accordingly also has to do with the sequence of realized events, which together allow a "form of life" to take shape for the rule, and a context for its use.

Within Kant's transcendental idealism, thanks to time – that is, to pure intuition (contemplation) rather than to the understanding – sense perceptions are ordered as a sequence of events, elements of reality. (For Leibniz, by contrast, the order of events is primary, and time is secondary, defined as the relation among events.) A retrospective view generates modal experience through the analysis of a sequence of past events; it establishes that something might have happened sooner, or later. This is a genetic way of identifying possibilities.

³³Kant's time, as is well known, is not merely an a priori form of intuition; it is multidimensional. In particular, it is a common source of the two forms of knowledge. According to Mai Lequan (Lequan 2007: 138), "(...) in the *Critique of Pure Reason* Kant reveals a complex time possessing several levels: pure intuitive time, the form of all inner and outer representations; the time of the subject's original self-affection, a productive synthesis of the transcendental imagination, the common root of understanding and receptivity; time as a simple scheme linking the concepts of understanding and sensible intuition; and time as the foundation of our objective experience of nature."

Kant's dualist conception of modality thus offers two different models of the possible: coexistence, and sequence (for more detail see Bitbol 2015, ch. 1). Their correction and synthesis seems to us to be possible within the framework of contextual realism.

We reject the Kantian division between two types of knowledge – a dualism between (conceptual) understanding (“spontaneity”) and sensible intuition (“receptivity”). In its place, we accept a categorical difference between the ideal, the intellectual, and the real, the sensible. Sense, understanding, thought, (ideal) representation, description, point of view, perspective, identification, norm, rule, concept, theory, and so on, all belong to the domain of the intellectual. The Perceptible is reality itself, not a sensible experience standing behind which there might lie some further thing in itself.

Any actual event is not simply given in its relevance, as a bare phenomenon; it also implies a certain tendency – a rule (norm), of which it is the realization. This indicates that the event could have happened otherwise, could have been different: that is, the same underlying conceptual structure could have yielded a different event. This real possibility is the special reality of the counterfactual event – the reality of the (already conceptualized) experience of the possible that accompanies the actual event. This is Wittgenstein's conceptual analysis at work: the identification of rules, the logic of phenomena. To know a rule is to know its possible uses: “We feel as if we should penetrate into the depths of phenomena, but our study is not aimed at phenomena, but, one might say, at the ‘possibilities’ of phenomena” (Wittgenstein, *Philosophical Investigations*, § 90).

So the event has an intellectual (conceptual) component: it is this component that allows us to speak of possibility – “something else might have happened” (in prospect), “something else could have happened” (in retrospect). The conceptual, that is, the rule governing the “language game,” contains the potential for the possible; the rule could (perhaps) have been applied differently. Real possibility is the possible application of a rule/concept; real possibility is thus rooted in relevance, and the (real) experience of the possible is bound up with it.

This understanding of possibility differs both from an a priori (logical) understanding of possibility as mere freedom from self-contradiction, and from a physicalist understanding of possibility as mere non-contradiction with the laws of physics. These are both intellectualist, decontextualized understandings of possibility; what they share is precisely their decontextualization. Borrowing Wittgenstein's terminology, let us say that such possibilities can be established (paradigmatic) possibilities within

the framework of this or that form of life – but they remain secondary. Real possibilities are contextual and, being rooted in facts, in realities, are, as already noted, accompanied by experiences of the possible.

It thus makes sense to speak of possibility only where there is use of concepts, only for meaningful event-facts. An “event” as a bare singularity – as a mere element of reality – has no “givenness” at all. Within what Bitbol calls “dazzling obviousness” (Bitbol 2015), such an “event” likewise loses all meaning: so there is no point in speaking of possibility with respect to it either.

By contrast, the concept of an “event” as a mathematical event – a point in a space-time manifold, or an abstract statement-fact, which we have already discussed above – is a pure abstraction, detached from reality. Here it is unclear how what actually happens could have happened otherwise, since there is no real experience of the possible – no connection between the event and the possible.

An event, as a phenomenon, occurs in space-time or, at any rate, in time; this is what we take the concept of a phenomenon to require. The identification (as true or false) of a given sound, for example, occurs at some point in time, but not at any point in space (although the identifying subject is, of course, located somewhere at that time – this, too, must be taken into account). A visual object, by contrast, is identified in both time and space. The event, as a phenomenon, is “given” to the subject who identifies it: the subject sees something, hears it, feels it, and so on – which presupposes the presence of consciousness.

Let us now show that interpreting modality in terms of contextual realism allows us to conclude that nothing is impossible, in the sense that a hypothetical possibility, if it is genuinely meaningful, is a real (possible) possibility, and a hypothetical impossibility, if it is genuinely impossible, is not really meaningful.

Let us distinguish between what is (the actual), what may be (the possible), and what is impossible. A denial of impossibility is necessary here. For Alexius Meinong, something impossible (something that does not exist), such as a round square, is nonetheless one among the types of object (Meinong 1915). For Franz Brentano, by contrast, thought cannot be directed at non-existent objects at all. Edmund Husserl introduces the concept of the “fulfillment of an intention”: for him, in the case of a round square, the corresponding intention is simply not fulfilled. Correcting Husserl’s phenomenology, Jocelyn Benoist treats the intention as the norm, and its “fulfillment” as satisfaction of that norm. If the intention is not “fulfilled” – that

is, if the norm is not satisfied – it makes no sense to speak of an object satisfying it: a “nonexistent object” is not an object at all, but simply a case of the norm’s non-satisfaction (Benoist 2016, *Logique du phénomène*, ch. 6).

We interpret the content of the intentional as the correct application of a Wittgensteinian rule (henceforth: “the rule”) within a language game rooted in reality.

There is no point in speaking of the limits of reality as such, of what is possible or impossible in some absolute sense. Modalities make sense only within the framework of a reality already conceptualized in one way or another – a “form of life” – that is, in relation to its norms, the c-rule that is implicit in the language games associated with it; modalities, in other words, presuppose the use of concepts.

We interpret metaphysical necessity – that is, conceptual necessity in the broadest sense (necessity “by the nature of things”) – as (conceptual) necessity relative to a rule, and metaphysical possibility as the possible use of a rule, relative to the “grammar” (the logical structure) of a form of life (Pris 2014, “Illusions...”).

By the “possible use of a rule” we mean a “use” about which we can correctly say that it is possible (that it may be, and so on). That is, we interpret possibility by means of a recursive scheme: “(...) may be” is true just when “(...) may be” is true. The corresponding modal statement (“language game”) – “(...) may be” – is associated with some (real) application of a rule, i.e., with a language game stating some real state of affairs, identifying some real object. In this sense, what a merely possible object refers to is probably not, itself, an object at all: the language of possible worlds is, rather, a figurative one.

Impossibility is the impossibility of applying a rule outside its domain of applicability, relative to a form of life; it is the impossibility of negating a necessity (a rule). Strictly speaking, such a negation makes no sense, because the limits of meaningfulness are the limits of the form of life. In other words, the impossible is not some object with a special nature of its own, different from the nature of the actual and the nature of the possible. In this, almost tautological, sense, there is (there exists) nothing impossible. Nothing is impossible in the sense of being some given to which there is, in principle, no access – but that is certainly not the same as the claim that “anything is possible.”

Since a form of life determines the kind of reality (and the kind of “naturalness”) at issue, it can look as though a given metaphysical impossibility were impossible owing to the nature of the things it concerns. In fact, for example, a square circle is

impossible not because a circle has some special nature that as a result cannot be made square (a nature that our idea of a square circle unsuccessfully tries to grasp, to realize), but because the concept of a square circle is meaningless from the standpoint of the concepts (norms) of Euclidean geometry. If we want to make sense of a square circle, we should try to develop other concepts – adjust our thinking to a new subject matter, rather than the reverse.

Within the framework of a form of life – a set of related, family-resembling language games – everything is possible, and indeed much is predetermined. Besides, from the standpoint of Wittgenstein’s dynamic conception of language games and forms of life, there is a sense in which the impossible is, or can become, possible: the impossible can become possible from the standpoint of a generalized c-rule (norm), an expanded form of life (within which the concept of metaphysical possibility thereby acquires a wider sense), while remaining impossible within the bounds of the initial form of life – that is, in the sense of the initial c-rule.

It is known, for instance, that within certain naturally generalized metric geometries, a square circle is possible: that is, it is possible relative to a different norm – though not one that is an arbitrary convention, unrelated to a square circle, but rather a norm that bears close structural, “natural” links to the Euclidean norm (Benoist 2017, *L’adresse du réel*: ch. 5). Contrary to Euclidean logic, then, the metaphysical intuition aimed at finding a square circle ultimately turns out to be, in a sense, vindicated.

What matters here is the “natural” generalization (expansion) of mathematics, one that preserves the links, the “family resemblance,” with already-established mathematical knowledge, and has a post-factum justification. Such generalization is rooted in mathematical reality; it is itself a mathematical reality, not an arbitrary convention. (The phenomenon of the radical expansion of mathematical concepts is studied by Imre Lakatos; Lakatos 1976.) A square circle is possible, really exists – but not within the framework of Euclidean geometry, only within a geometry with a different metric norm. (From a purely topological point of view, there is, in fact, no difference at all between a square and a circle.) Thus even what is “a priori impossible” can be possible. Discovering such a possibility requires action, not mere contemplation.

And conversely, it can happen that, within a new “reference frame,” what was previously possible becomes impossible. The Heisenberg uncertainty relation, for example, establishes the impossibility of simultaneously and precisely measuring the position and momentum of a quantum particle. A mistaken interpretation of this fact might hold that such a simultaneous measurement makes sense – that the particle has

precise values of position and momentum, which we simply cannot access. This is an attempt to force a new reality into old concepts. The impossibility here is, rather, the logical impossibility of applying classical mechanics, as a set of c-rules, outside its own domain of applicability.

New rules (norms), like new objects, are not predetermined: they are developed within a reality that always exceeds the language games and forms of life already in place. They bear on new contexts, and their application likewise depends on context. A correct view of modality implies contextual realism, and rejects the metaphysical realism of predetermined objects, properties, relations, and structures – a position that, in essence, conflates the normative and the real by hypostatizing the former.

The metaphysical realist is a dogmatist: he tries to fix rigid boundaries for the possible. The idealist, by contrast, tries to overcome every boundary too quickly, breaking free of reality and operating with pseudo-concepts. Both, however, are absolutists; both appeal to a decontextualized ontology, disregarding the contextual nature of modality.

Absolutized modalities are treated as though they were specific objects. But possibilities and impossibilities are not objects. Speaking of the objective existence of possibilities and impossibilities as such leads to the erroneous assignment of one and the same status to the actual, the possible, and the impossible alike: everything comes to seem as though it existed, though differently; everything comes to seem real, though to differing degrees.

Our view of modality is thus moderately deflationary: it emphasizes the correct use of language while rejecting conventionalism (true thought, and a genuine language game – that is, real action, as opposed to something merely imaginary – cannot be mere conventions). It does not reject ontology; it contextualizes it.

“Modal Substitution Realism”

According to Michel Bitbol’s “modal realism of substitution,” the concept of an *effectivement survenu* – an event that occurs prior to its linguistic and theoretical description – should be discarded as inapplicable to quantum mechanics (Bitbol 2015, ch. 5). This allows the concept of locality to be preserved within quantum mechanics.³⁴

Quantum correlation is, of course, a real correlation between experimental events – between one “here and now” and another “here and now” (perhaps at the same “now”). If one supposes that quantum correlations amount to a correlation between independent events (substantial events) that share some general cause, a riddle and a dilemma remain – either action at a distance, or non-locality. Since the classical causal link between events must be excluded, so too must the classical conception of what such events are – their classical ontological status.

If one rejects the idea of an event as a certain “object” (in the general sense) situated in the “outer world,” one that really exists with a well-defined identity prior to its being expressed as a fact, one must accept that a given event exists only at the moment of its identification by quantum rules. Correlation is simply the implementation of the rules of quantum mechanics, rules that allow us to organize quantum-experimental practice and to predict its results (the correlation in question).

This is not instrumentalism, or not pure instrumentalism, since the existence of quantum objects is still recognized. As a result of measurement, for example, it turns out that a quantum particle really does have this or that spin: spin is a real property of a really existing quantum particle.

“Modal Realism of Substitution (or Participation)” takes into account the practice

³⁴The notion of locality in quantum mechanics is also what Carlo Rovelli tries to save (Rovelli 2018). Rovelli holds to a relational interpretation of quantum mechanics; for him there are only quantum events “here and now” (that is, ontology is admitted, pure instrumentalism rejected), and theory only establishes a relationship between them.

of the subject who applies the theory and participates in experimental practice. Its formulation is conditional, not categorical: it involves the participation of a cognizing subject.

According to Bitbol, the only thing we can say about reality is this: (1) if the experimenter makes such-and-such preparations and such-and-such measurements, then the community will observe such-and-such outcomes with a probability that follows the Born rule; (2) if the experimenter prepares an entangled wave function and participates in the measurement, a correlation will be observed (Bitbol 2015: 335–336). Wave functions “explain correlations” in the sense that they describe the conditions under which correlations will be observed. In this sense – and only this sense – these functions are real; we say that they are “rooted” in reality, that is, that they have real conditions of their application.

The principal difference between Bitbol’s approach and, say, David Lewis’s modal realism – which transforms the intensional into the extensional in terms of possible worlds – is that, for Bitbol, every expression implies engagement, the participation of the one who utters it, in the cognitive process. The resulting modal realism, which includes an acting, cognizing subject, is conditional rather than categorical (Bitbol 2015: 335).

A non-classical theory such as quantum mechanics thus requires a non-classical understanding of reality: it requires taking into account the pragmatics of the subject’s use of language, including the language of theory, and the practice of experiment and of applying the theory.

In everyday life, and in classical physics, there is a common misconception that the fact expressed in language reflects some meaningful event that took place in the world independently of, and prior to, its linguistic or theoretical formulation. This runs contrary to the pragmatic point of view. For John Dewey, for example, there is no isolated object or event in real, lived experience: an event or object is always this or that part, this or that aspect, of the world or a situation – that is, the event depends on the situation, on context (see the discussion of Dewey in Bitbol 2015: 337–338).

“Fact” does not refer to a singular, predetermined (self-conscious, self-determining) event; rather, the fact determines the event. In this sense the event is not autonomous with respect to the relevant fact. From the standpoint of quantum mechanics there is no dualism of fact and event; a quantum fact differs from a classical fact precisely in that it presupposes pragmatic conditions of its own existence, rather than formulating

a predetermined event that is independent of them.

(...) Events owe their singularization only to the norms governing the enunciation of facts. Events are nothing outside of facts; the things that happen in the world do not happen independently of what our statements state. (Bitbol 2015: 339.)

What has just been said may look like idealism, but it is not: it is “modal realism of Bitbol’s substitution.” The statements of quantum physics lack a referent only in the classical sense. A statement’s referent is not isomorphic to the statement; there is no one-to-one correspondence between a statement and its referent, between an event and its linguistic representation. In particular, a classical event is not a quantum referent – but that does not mean there is no real referent at all. In quantum physics, what the quantum description refers to is everything that can be referred to the real: the sequence of events arising in experiments, governed by the law of probability – that is, such-and-such possible events, with such-and-such probabilities. Isolated, decontextualized, wholly autonomous, absolute objects or events do not exist (Bitbol 2015: 340).

For Bitbol, in a sense, wave functions are “real.” We understand this reality not in the metaphysical sense of a simple correspondence to some determinate referent, but in the sense of being rooted in reality: the wave function determines certain real conditions (and is itself determined by them) under which particular measurement results can be observed with one or another probability. In other words, it remains possible to speak of a referent, but the referent turns out to be of a more complex nature than in classical physics.

It is precisely the assumption of an intimate connection between theory and reality that allows us to deny that the position in question is instrumentalism: the wave function is not merely a mathematical tool for prediction.

The real purpose of a theory is to establish a meaningful connection between us and reality – to allow us consciously to navigate within reality, to do something meaningful. This connection need not be presented as a reciprocal reflection of an “independent reality.” In general, it describes the real conditions under which action, the application of theory, and, in particular, the prediction of phenomena, are possible. A successful theory expresses the logical structure – the “grammar” – of a real practice, within which real quantum phenomena are identified.

Quantum Ontology

In § 242 of the *Philosophical Investigations*, Wittgenstein writes:

Linguistic understanding is achieved not only by the consistency of definitions, but also (strange as it sounds) by consistency of judgment. It seems to eliminate logic, but nothing like that happens. It is one thing to describe methods of measurement, another to take and state measurement results. And what we call “measurement” is also determined by a certain constancy in the results of measurement.

Agreement in Wittgenstein’s “judgments” is agreement on well-established language games and forms of life. Without such agreement, neither mutual understanding nor judgment is possible. Such agreement, in turn, presupposes an already-developed ontology: within the framework of well-established language games, some real objects (not necessarily visual ones) are identified.

Wittgenstein’s pragmatic approach to ontology differs from the semantic approach, on which metaphysical realists claim the existence of a predetermined, primary reality of well-defined individuals, together with their properties and relations, which are then secondarily reflected in language, while anti-realists claim that ontologies are instead formed out of an initially shapeless field of appearance, as a result of the choices language makes. These are, evidently, two extremes; their common origin can be understood, and thereby dissolved, within the framework of contextual realism.

The distinction between appearance and real being that we find in Socrates, Plato, and Aristotle – and, correspondingly, the understanding of ontology as real being – disappears within the semantic approach.

The trouble with the semantic approach is that it neglects pragmatics. Wittgenstein’s pragmatic (contextual) correction allows us to dissolve the otherwise insoluble

opposition between realism and idealism (anti-realism). The use of language is contextual; it does not construct things (objects) but identifies them. Accordingly, things acquire determinacy (become objects) only as a result of such identification in context. They are not predetermined, as the metaphysical realist claims. What is non-contextual, within known limits, is not ontology, but the theoretical and experimental methods used to describe and predict quantum events.

Bitbol reaches similar conclusions (Bitbol 2015: 439):

(...) the referent results neither from a prior, arbitrary carving-up of the continuum of appearance into units of sense, nor from a passive mapping of words onto pre-existing things; it relies on a strategy of perceptual and instrumental anticipation.

(The referent is neither the result of a preliminary, arbitrary division of the continuum of appearance into semantic units, nor the establishment of a passive correspondence between words and predetermined things; he relies on a strategy of perceptual and instrumental anticipation.)

Bitbol continues:

What makes a reference relevant is the fact that the speaker, in uttering a name, undertakes to supply his partner with enough elements that the latter can, on the one hand, identify what he means in the future and, on the other hand, attach this designatum to documents concerning his past.

The contextual (pragmatic) approach makes it possible to establish links between different concepts of ontology. This is not surprising, since different ontological concepts have emerged as a result of ignoring pragmatics. In particular, Bitbol shows that the pragmatic approach establishes a link between the semantic, the phenomenological, and the Aristotelian conceptions of ontology.³⁵

³⁵ Aristotle's position is the closest to that of contextual realism. For Aristotle (cf. Book Γ, part 4, of the *Metaphysics*), according to Aubenque, "every language, not insofar as it is such, but to the extent that it is understood by others, (...) [is an] ontology" (Aubenque 1977: 131–132; quoted in Bitbol 2015: 442). Bitbol understands these words in the sense that language

Science does not give us knowledge of new properties of the very same predetermined things of the “outer world” to which it is asymptotically approaching; rather, it gives us knowledge of new slices of reality. The grain of truth in anti-realism is that we can choose – though not create – these slices of reality, in a certain sense, by choosing this or that descriptive language, this or that experimental method of research, this or that norm, this or that form of life. Within certain limits, we are able to choose our own norms and to pave our own way through reality. (A familiar grain of truth in scepticism is that we are, from the outset, already part of some given form of life: we cannot change forms of life the way we change gloves.)

From our point of view, unconceptualized reality as such has no specific nature (it makes no sense to speak of its nature). Quantum theory identifies a special region of reality – a quantum reality that does have its own nature (since quantum reality is already a domain of conceptualized reality). In turn, this or that particular quantum state identifies a particular slice of quantum reality. In the process of measuring a physical quantity, one or another, perhaps even more specific, reality is thereby identified. We understand this identification, accompanied by a “reduction” of the initial wave function, as a contextual identification, rather than as a substantial “process” of measurement. The nature of quantum reality is probabilistic and dispositional. It is not a visual object, nor is it not a visual object.

Note that the concept of “context” we use here indicates that what is at issue is the identification of a certain quantum reality (and not some physical process of “reduction”), one that, at the same time, turns out to be defined only as a result of this identification – that is, it is not predetermined, and did not exist as an object prior to its identification. Contextuality means the absence of predetermination, the absence of certainty in advance. The word “identification” emphasizes that what is at issue is not the construction of reality, of a real object.³⁶

creates a “hearth” (*foyer*) in which there are “anticipations and intentions of interlocutors,” and calls these hearths substances (Greek *ousia*). A pragmatic genealogy explores how the roots of language in pragmatism can redefine the Aristotelian “hearth.”

³⁶Bitbol distinguishes three levels of relativity (contextuality) of observed physical quantities: (1) the choice of measuring device, and its type (it is possible, for example, to measure the position of a quantum particle, its momentum, or its spin); (2) the activation of the measuring device at the moment of actualization – that is, the sudden transition from a superposition of states to a state with a determinate value of the physical quantity; (3) “consciousness” (von Neumann speaks of an “abstract self,” which is a non-object, a pseudo-object, a non-physical *relatum* – a version of the transcendental Husserlian ego; von Neumann 1964; Bitbol 2019: 262). We are speaking of a subject, or an observer, who uses theory in context (applying it to

Bitbol holds that the concept of an object does not apply within quantum mechanics. We, however, propose to expand the concept of the object. For us, an object is simply something that has determinacy, identity: any identification by means of any concept, in this sense, counts as an object. The wave function, for example, although it does not identify (describe) an object in the sense of a visual object of classical mechanics, does identify an object, in the sense of a determinate dispositional reality (a reality which, we should note, is itself not absolute, but depends on the context of observation – see, e.g., the discussion below). The concept of the object, however, does not apply to reality as such.

Within Everett's interpretation, all possible results of measuring a given physical quantity are, as it were, simultaneously present. This must be understood in terms of potentials, dispositions, that are not reducible to anything more fundamental.

For example, within the original interpretation of Everett, the state of quantum correlation of two particles is a combination of the states of those particles: the state of each is not determinate in itself, but is treated as relative to the state of the other. Upon measurement, the relative state is updated. The many-worlds interpretation (or the interpretation that introduces many consciousnesses) treats all possible states as simultaneously realized in different worlds (or consciousnesses). We understand the relativity that Everett points to, not as an ontological predetermination across different worlds, or in some other such way, but as a relativity to context: this or that particular correlation is realized as a result of measurement – which means identifying it in context.

The “process” of measurement, on the one hand, presupposes the choice of a given experimental and theoretical setting, and, on the other, involves the transition from the potential to the actual – an actualization that has no bearing on the domain of applicability of the theory. In other words, the “process” of measurement is the application of quantum theory as a c-rule, as a result of which the logical “gap” between it and reality is closed within a language game.

reality). Any use of concepts, application of theory, or phenomenon presupposes a subject who uses concepts, applies theory, observes the phenomenon. This is a logical (“grammatical”) fact, one that, once taken into account, allows us to dispense with transcendentalism and subjectivism. As a result, we are not dealing with relative values of physical quantities, but with their absolute values for the real things themselves. The “consciousness” that accompanies the act of measurement has an experience of real contact with reality; such “consciousness” belongs to the category of the real, not the ideal – it is part of reality.

Our interpretation is consistent with Michel Bitbol's position:

'Reality' in a strong sense can (...) be characterized, but it is characterized no more than as a 'substrate of absolute and non-referenced potentials' for the 'available freedoms' of experimental action. (Bitbol 2015: 459; Bitbol here draws on the ideas of Mugur-Schächter; Mugur-Schächter 1992.)

This “substrate of potentials” is the most plausible meaning to give to the “universal state vector” of quantum mechanics, on Everett's pragmatic interpretation.

For Bitbol, modal substitution realism and quasi-realism complement one another: the wave function describes not an object, not a set of parallel worlds (or a split world), but a substrate of potentials, each of which can be actualized – and, fully in keeping with quasi-realism, each is actualized only within the framework of a given experimental setting.

In other words, the wave function is a tool for quantum-mechanical prediction: in this sense it plays the role of a performative attitude. On the other hand, the elements of its decomposition simulate an ontology within a given “objectifying” unit. These two settings complement one another: the first corresponds to modal realism of substitution, since it introduces a reality of potentials in place of the predetermined reality of objects with properties; the second is associated with the quasi-realism of theoretical objects.

Thus, for Bitbol, there is a dissociation between reality (as such) and ontology – between reality and objects. Within the framework of contextual realism, this corresponds to the difference between reality as such, the notion of reality, and this or that particular (contextual) reality – a contextual ontology. Reality as such has no conceptual dimension, in the sense that it makes no sense to speak of it as having one – not in the sense that it lacks the positive property of having a conceptual dimension, but in the sense that the conceptual dimension simply does not apply to the concept of reality. Ontologized reality, on the contrary, is precisely conceptualized reality.

The Combination of “Modal Substitution Realism” and Quasi-Realism

Michel Bitbol rejects the idea of a predetermined datum of existence that quantum mechanics might capture or describe (Bitbol 2015). This is the point of similarity between his position and contextual realism. At the same time, he rejects the notion of a theory-independent reality that theory simply describes, thereby moving closer to neo-Kantianism. More precisely, Bitbol interprets quantum mechanics by combining his “modal substitution realism” with the quasi-realism of Simon Blackburn (see, e.g., Blackburn 2002). The former denies that reality itself is an object, or consists of predetermined objects in the image and likeness of the objects of everyday life around us – in essence, it is a rejection of metaphysical realism. The latter is, at bottom, a meta-ethical position, though it can be understood more broadly, in particular with regard to the philosophy of science.

In ethics, the position of quasi-realism attempts to steer a middle course between emotivism (expressivism), which holds that ethical statements are simply the expression of emotions possessing no truth conditions, and metaphysical realism (Platonism), which holds that they express predetermined (absolute) ethical facts and are accordingly either true or false. Quasi-realism accepts that an ethical statement expresses a certain stance, but at the same time holds that, within that stance, it is true or false. More precisely, on the quasi-realist view, an ethical statement behaves *as if* it were asserting a truth.

The quasi-realist component of Bitbol’s proposed interpretation of quantum mechanics operates at the level of objectification. Within the bounds set by the choice of a given experimental and theoretical setting, this or that quasi-ontology arises (whereas, prior to that – that is, before performing a given quantum-mechanical experiment, measuring a given physical quantity – it was possible to speak only of potentials, dispositions).

In our view, the combination of “modal substitution realism” and quasi-realism that Bitbol proposes fits well with the contextual realism developed by Jocelyn Benoist and by us (Benoist 2017; Pris 2018). Moreover, contextual realism makes it possible

to improve upon Bitbol's view, understanding it as genuinely realist, fully freed from any residue of neo-Kantianism. Bitbol's pragmatic interpretation of Everett is likewise best articulated within the framework of contextual realism (Bitbol 2015; Pris 2016).

For example, within the framework of Everett's original interpretation, the state of quantum correlation between two particles is a combination of the states of those particles: the state of each is not determinate in itself, but is treated as relative to the state of the other. Upon measurement, the relative state is updated. The many-worlds interpretation (or the interpretation that introduces many consciousnesses) treats all possible states as simultaneously realized, in different worlds (or consciousnesses). We understand the relativity that Everett points to, not as an ontological predetermination across different worlds or in some other such way, but as relativity to context: this or that particular correlation is realized as a result of measurement – which is to say, is identified in context.

The “process” of measurement, on the one hand, presupposes the choice of a given experimental and theoretical setting; on the other, it involves the transition from the potential to the actual, an actualization that bears no relation to the domain of applicability of the theory. In other words, the “process” of measurement is the application of quantum theory as a c-rule, one whose application closes the logical “gap” between theory and reality within a language game.

Our interpretation is consistent with Michel Bitbol's own position:

‘Reality’ in a strong sense can (...) be characterized, but it is characterized no more than as a ‘substrate of absolute and non-referenced potentials’ for the ‘available freedoms’ of experimental action. (Bitbol 2015: 459; drawing on the ideas of Mugur-Schächter; Mugur-Schächter 1992.)

This “potential substrate” is the most plausible meaning to give to the “universal state vector” of quantum mechanics on Everett's pragmatic interpretation.

On Bitbol's view, modal substitution realism and quasi-realism complement one another. The wave function describes, not an object, not a set of parallel worlds (or a split world), but a substrate of potentials, each of which can be actualized; in full accordance with the position of quasi-realism, actualization occurs only within the

framework of a particular experimental setting.

In other words, the wave function is a tool for quantum-mechanical prediction: in this sense it plays the role of a performative attitude. On the other hand, the elements of its decomposition simulate an ontology within a given objectifying unit. These two settings complement one another: the first corresponds to modal substitution realism, since it introduces a reality of potentials in place of a predetermined reality of objects with properties; the second is associated with a quasi-realism of theoretical objects.

Thus, for Bitbol, there is a dissociation between reality (as such) and ontology, between reality and objects. Within the framework of contextual realism, this corresponds to the difference between reality as such – the notion of reality – and this or that particular (contextual) reality, a contextual ontology. Reality as such has no conceptual dimension, in the sense that it makes no sense to speak of it: not in the sense that it lacks the positive property of having a conceptual dimension, but in the sense that a conceptual dimension simply does not apply to the concept of reality at all. Ontologized reality, by contrast, just is conceptualized reality.

Contextual Realism and Quasi-Realism

For Wittgenstein, any word, including the word “good,” has different uses within different language games. Wittgenstein writes: “Whenever you run into such a difficulty, ask yourself the question: how did we learn the meaning of this word (for example, ‘good’)? From what examples, in what language games? You will then find it easier to see that the word must have a whole family of meanings” (Wittgenstein, *Philosophical Investigations*, § 77). That is, there is no single property “good,” as G. E. Moore supposed. If we accept this, we can also conclude that moral judgments cannot be explained within the framework of a single moral theory (Sharp 2018). In other words, for Wittgenstein, ethical statements, their evaluation, and their justification, are all contextual. There are moral principles fixed by a “form of life” (a shared background), and there are applications of them that can be true or false. The same idea is put in Kantian terms by Winch, who holds that Wittgenstein’s philosophy contains both moral principles and moral sensitivity. For Wittgenstein, according to Winch, “the law without sensibility is empty, [and] sensibility without law is blind” (Winch 2019).

Within the framework of the contextual realism we adopt – itself an interpretation of the later Wittgenstein’s position – real things can have physical, social, and ethical dimensions all at once. There are ethical facts (against moral eliminativism and reductionism), but these facts depend on context (against moral Platonism).

Indeed, the very existence of ethics – the science of how to act rightly – requires realism, and hence moral realism: an act presupposes the reality within which it is performed, and it can be right – in which case we are dealing with a moral fact – or not. Moral realism can only be contextual, because ethical norms and their applications are not fixed once and for all, but are developed in reality and applied in context. Contextual moral realism thus obviously implies contextual realism *tout court*. (On contextual realism in ethics, see Benoist 2017, ch. 10.)

Blackburn’s position – “quasi-realism” (a term that does not originate with him) – draws its inspiration from the philosophy of the later Wittgenstein and, in par-

ticular, from the problems of rule-following. Blackburn even holds that the later Wittgenstein can be read as a quasi-realist (Blackburn 1981: 172). In the spirit of the later Wittgenstein, Simon Blackburn tries to work out what we are doing when we use an ethical language (Blackburn 2002). His explanation of the use of ethical language does not involve carving reality up into semantic units, nor does it posit a passive correspondence between words and predetermined things; rather, he relies on a strategy of perceptual and instrumental anticipation. (Similarly, within contextual realism, the description of a language game is, at the same time, both an explanation and its own justification, since it describes the correct application of the rule/norm governing that language game.)

Quasi-realism is a dynamic view of ethical judgments. The starting point is that such judgments are attitudes, rather than descriptive statements. At the next stage, however, they come to be treated “as if” they were true statements. Bitbol holds that the quasi-realist starts from an anti-realist *tabula rasa* and ends up a “methodological” realist (Bitbol 1994).

Consider, for example, two proposals concerning causality (Bitbol 1994). The quasi-realist begins with the sentence (p1) “We should conduct our research as if all things had their reasons.” This is a methodological proposal – a regulative principle: it does not claim that reasons are real, only that research should proceed as if they were. The quasi-realist ends with (p2) “All things have their reasons” – a metaphysical proposal, a constitutive principle, one that claims the reality of reasons. The realist accepts (p2), and can therefore accept (p1); the reverse seems impossible. But, from Blackburn’s point of view, this seems impossible only for a realist (i.e., a traditional realist): “A principle can only be *constitutive* as opposed to a *regulative* one if there is an area of facts whose constitution it is intended to describe” (Blackburn 1993: 26).

In terms of contextual realism, we interpret (p1) as the choice of a rule/norm – in the case of the philosophy of physics, the choice of a theory – within the bounds of contextual realism, corresponding to an ethical stance within quasi-realism. The application of a norm (theory) in context is either true or false; similarly, the application of an ethical norm in context is true or false, though the ethical norm itself is neither true nor false but rather an attitude. The norm, however, can be brought into line with the “ethical reality” of well-established ethical language games – and in that sense it is true.

The application of a norm (a setting) is, in Wittgenstein’s language, a “language game,”

and analyzing it is necessary for understanding the meaning of an ethical statement. Indeed, Blackburn's quasi-realism combines expressivism with the philosophy of ordinary language: for Blackburn, moral language expresses attitudes. In making ethical statements, we *do* something – we express attitudes that shape our plans, intentions, and behavior. At the same time, we speak as if our ethical statements were true, as if there were a normative (ethical) reality corresponding to them. That is why the position is called “quasi-realism.”

Plato believed in the existence of an ethical reality. Quasi-realism, however, is not metaphysical Platonism: ethical facts are not metaphysical facts. Blackburn also rejects Aristotle's teleological view, on which ethical facts have a purpose. Within contextual realism, an attitude, or norm, is not a predetermined natural purpose but a point of view, a perspective.

Quasi-realism is an explanatory strategy: it supplements expressivism with a clarification of its genealogy – that is, with an account of how some ethical stance becomes an object of thought.

Blackburn's quasi-realism – his expressivist (practical) approach – allows us to speak of knowledge, including moral knowledge. We know, for example, that the sentences “You should not be cruel to children,” “Pleasure is better than pain,” and “It is better to be rewarded on merit than not” are true. On the other hand, not all of us know whether the sentence “There should be a minimum wage for workers” is true.

Quasi-realism's stance on the possibility of ethical knowledge is supported by deflationism about truth.³⁷ Deflationism dispenses with the metaphysical concept of truth as conformity, and thereby brings together descriptive statements like “Snow is white” and ethical statements like “It is immoral to torment animals.” According to deflationism, the sentence “Snow is white” is true if, and only if, snow is white; similarly, we can say that the sentence “Torturing animals is immoral” is true if, and only if, torturing animals is immoral – that is, if, and only if, we sincerely say (think) that torturing animals is immoral. (Blackburn speaks here of the expression of a stance.) Quasi-truth can thus be understood, not as a substantial property, but as deflationary truth – truth not in the sense of literal conformity (conformity in the substantial sense – theoretical reconstruction).

We interpret quasi-truth as conformity in context, as the correct application of a

³⁷The deflationist claims that the sentence (statement, judgment) “*p*” is true if, and only if, *p*.

quasi-realist stance in context.

We distinguish between rules (norms) – such as “snow is white,” “torturing animals is immoral” – and their application in context. The set of well-established (paradigmatic) applications of a rule fixes its domain of applicability, the rule itself. We can accordingly say of the rule that it is (as it were) true, that it corresponds to an ethical fact – an analogue of metaphysical truth in the sense of conformity. Strictly speaking, rules (norms) as such are neither true nor false; they are true or false only in their application.

Contextual realism is thus a moderately deflationary position: ontology is not rejected, but contextualized. The phrase “snow is white,” for example, is true (or false) in context; and if, in that context, we correctly say that snow is white, then it really is white – that is, the property “white” is its real property. Ethical statements refer to ethical facts and properties in exactly the same way, within their own context.

It should be noted that a choice can be made, not only between correct (true) and incorrect (false) applications of norms, but between the norms themselves, ethical norms included. The problem of choosing among norms is analogous to the problem of choosing among forms of life; in both cases there can be radical disagreements that can only be resolved in practice.

Although quasi-realism is, in the first instance, an ethical position, it can be transferred to other domains. Blackburn, for example, uses it to understand how we can have knowledge of the probability of an event.

Frank Ramsey argued that, in speaking of probabilities, we express a degree of subjective certainty, and thereby a belief that the relevant sentence is true. The question remains how, and whether, we know that the sentence “the probability of event A equals p ” is true. According to Blackburn’s quasi-realist position, an opinion (statement) about a probability can be more or less justified, like any opinion, and if sufficiently justified, can amount to knowledge:

People may ask: how do you know that the half-life of the radioactive atom is a hundred years? What could ground that probability? I would say, “Yes, you can [know it].” There are degrees of confidence one can stand behind. Suppose you don’t know the probability, that you’re guessing. But there is, again, the possibility of more and more solidly grounded opinion, until eventually you no longer feel there is room for

improvement. That is when you begin to talk of knowledge. (Blackburn, Interview.)

Schrödinger's Quasi-Realism

Bitbol holds that, long before Blackburn, a form of quasi-realism was developed by Schrödinger in physics (Bitbol 1994). Schrödinger's philosophical position was neither straightforwardly realist in the traditional sense, nor straightforwardly anti-realist; hence some physicists and philosophers have read him as a realist, others as an anti-realist. On the one hand, Schrödinger preached an "idealist monism"; on the other, he treated the wave function and other theoretical objects as "real," in the very same sense in which the macroscopic objects around us – tables and trees – are real. He understood realism about the latter, however, not in the traditional sense of predetermined objects of the "outer world," but in pragmatic-linguistic terms. This allowed him to compare such objects with theoretical quantum objects, which are likewise identified through theory and experience. Starting from a "derealization" of the material objects around us, Schrödinger reasons like an anti-realist: at this stage he establishes that certain macroscopic and microscopic objects (objects, by definition, being determinate) do not exist by themselves – do not exist, so to speak, in their own autonomy or absoluteness – but only in context, that is, within a pragmatic-linguistic perspective that turns things into objects. At the next stage of the argument, this same starting point allows theoretical objects, too, to be treated as "real." At the same time, the "reality" of the wave function and other theoretical objects remains non-metaphysical: the wave function, which "represents" the quantum system, is not put into "correspondence" with the system as though the latter were some absolute reality existing in the "outer world." Schrödinger rejected the very concept of an "outer world": the "I" and the world it observes are, for him, inseparable. In our terms, Schrödinger's theoretical objects turn out to be "real" in the sense of being rooted in reality – that is, in the sense that they allow us to identify, in context, real objects of this or that kind. Bitbol accordingly sees, in Schrödinger's movement from an initial anti-realism to a subsequent "methodological" realism, a quasi-realism in physics of the same kind that Blackburn later developed in ethics (Bitbol 1994; Blackburn 1993).

From our point of view, Schrödinger systematically allows the ideal (theoretical) and the real to blend into one another. At the same time, this blending turns out to be

fruitful, since it allows him to abandon the metaphysical picture of reality; and, at a further stage of the argument, it is partly eliminated again.

Indeed, as noted, Schrödinger compares the reality of macroscopic objects with the “reality” of theoretical objects – itself a kind of anti-realism, since the real is here treated as a standard for the ideal. It is then asserted that theoretical objects are just as real as macroscopic objects – itself a kind of anti-realism too, since the ideal is here taken for the real. There is, in short, a mixing of categories. At the same time, it is possible to interpret Schrödinger’s procedure in Blackburn’s terms: a quasi-realist reading of Schrödinger’s approach holds that the wave function and other theoretical structures identify the reality of a given kind within context “as if” they were real. In the same way, strictly speaking, the reality of tables and trees is identified through the everyday concepts we have mastered since childhood, and whose presence, for this very reason, we no longer notice.

In the transition from metaphysical anti-realism to “methodological” (that is, non-metaphysical) realism – Bitbol’s own term – Schrödinger’s wave function comes to describe, as if to “represent,” the real system. The quasi-realist “as if” means that the system so described (represented) does not, in fact, have the status of an isolated metaphysical reality. On Schrödinger’s view this holds equally for tables and trees: they, too, are “kind of” real in the metaphysical sense. In fact, they are real – “really real” – and possess a certain existence within our form of life, but not in the metaphysical sense.

For Bitbol, Schrödinger is “not a realist.” If by this we mean “not a metaphysical realist,” we agree. But if by this we mean a position that falls short of full-blown realism, then such a position can only be a kind of idealism, or a realism with an admixture of idealism. Bitbol also claims that Schrödinger’s methodological realism is rooted in his own metaphysical anti-realism. On a contextual reading, we would say instead that the ideal is rooted in the real, and that ontology is secondary to reality itself, and contextual.

Bitbol holds that a further definition of reality given by Schrödinger is anti-realist:

(La réalité) se donne pour nous, en quelque sorte, comme la figure d'intersection des déterminations de plusieurs observateurs individuels – voire de tous les observateurs individuels concevables. Elle est un condensé de ce qu'ils ont trouvé dans un but d'économie de pensée.
(Reality is given to us, in a sense, as the figure of intersection of

the determinations of several individual observers – indeed, of all conceivable individual observers. It is a condensation of what they have found, for the sake of economy of thought.) (Schrödinger, letter to Einstein, 18 November 1950, in K. Przibram, ed., *Letters on Wave Mechanics*, Philosophical Library, 1967; quoted in Bitbol 1994.)

In our view this is not a definition of reality as such, but a definition of how this or that particular reality is given to us within a phenomenon – a definition, that is, of our world (our “form of life”), consisting of all the various “language games,” the various phenomena, given to us within all the kinds of phenomena that involve individual observers. Reality itself is what it is: that is its only definition.

Thus, genuine theoretical objects – as opposed to pseudo-objects – are rooted in reality, and it is only in that sense that they are “real.” In themselves they are ideal: they belong to the category of the ideal. Theoretical objects are real settings, rules/norms that allow us to identify real objects which, in their reality, are indistinguishable from macroscopic real objects such as tables and trees. The difference between them lies, not in reality, nor in some “degree” of reality, as though objects of one kind were somehow less real than objects of another, but in the nature of the reality involved: the nature of microscopic reality is different from the nature of the macroscopic reality that surrounds us. Heisenberg understood this very well.

Bitbol, believing Schrödinger to have been a quasi-realist fifty years before Blackburn, also finds affinities between quasi-realism in physics and Arthur Fine’s “natural ontological attitude” (Fine 1986). Neither position claims that scientific progress brings us closer to some predetermined, final ontology of the physical world; both can easily accommodate a Kuhnian paradigm shift, whether or not transparadigmatic elements or structures are present. The difference between the two is that quasi-realism is the more flexible position: where the “natural ontological attitude” tries to preserve some of the ontology natural to a given view, quasi-realism is readily prepared to replace it with a more elegant or more convenient one. This is consistent, in spirit, with Wittgensteinian contextual realism, which we take to be a clarification and deepening of the quasi-realist position. Blackburn, too, holds that the later Wittgenstein can be read as a quasi-realist (Blackburn 1981).

If Schrödinger’s quasi-realism can be understood in terms of contextual realism, how far is his position from Heisenberg’s? After all, we likewise interpret Heisenberg’s position as a form of pragmatism and contextual realism. One might equally ask how close the instrumentalism and operationalism of the Copenhagen philosophers

come to quasi-realism. It seems to us that the founding fathers of quantum physics differed far less in their philosophical views than might appear at first sight: looked at carefully, their views are all aspects of a deeper, non-metaphysical position, which we take to be contextual realism.³⁸ Their profound knowledge of philosophy, of quantum theory, and of physics generally, was the key to this convergence.

Let us quote Heisenberg, for example (Heisenberg 1958, 1971: 188):

(...) l'interprétation de Copenhague n'est aucunement positiviste, car, là où le positivisme prend comme base les perceptions sensorielles de l'observateur (...), l'interprétation de Copenhague considère que ce sont les choses et les processus descriptibles à l'aide des concepts classiques – c'est-à-dire le réel – qui sont les fondements de toute interprétation physique. (The Copenhagen interpretation is by no means positivist, because where positivism takes the sensory perceptions of the observer as its basis (...), the Copenhagen interpretation holds that it is precisely the things and processes describable with the help of classical concepts – that is, the real – that form the foundation of any physical interpretation.)

As for Bohr, he takes the purpose of physics to be, not to reveal the true “essence of phenomena,” but to try to establish relationships among the many aspects of experience (Bohr 1934). Petersen quotes Bohr as follows: “There is no quantum world. There is only an abstract quantum-physical description. It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature” (Petersen 1985: 305; quoted in Mamchur 2014).

Some authors interpret Bohr as an objective anti-realist; others read him as a realist. Michel Bitbol interprets Bohr's position as neo-Kantian in a broad sense. At the same time, Bohr, as we know, makes essential use of the concept of context in interpreting quantum phenomena; the accusations of positivism and instrumentalism leveled against him by Einstein and Schrödinger are accordingly unfounded.

As for Einstein's own position, it is not metaphysical realism, as supporters of the Copenhagen interpretation accused him of holding. Fine holds that Einstein's position

³⁸As Howard Stein puts it, “(...) there is no difference – no difference that *makes* a difference” (Stein 1989) between a cogent, enlightened “realism” and a sophisticated “instrumentalism.”

is “a natural ontological attitude” – what we would call Einstein’s non-metaphysical realism. Consider, for example, what Einstein himself writes (Einstein 1936: 315; quoted in Howard 2010):

The only thing that really matters is success in ordering the empirical data economically. The rules connecting concepts should be specified only in general terms, since otherwise it would be impossible to know in advance the kind of result one is trying to obtain. These rules can be compared to the rules of a game: they are, in themselves, arbitrary, though it is their being fixed that first of all makes the game possible at all. The fixing of the rules, however, can never be final: at most it can be said that they are well suited to the domain of facts to which they are meant to apply (i.e., there are no synthetic-a-priori categories, in Kant’s sense).

Einstein’s remark contains both the concept of a rule and a comparison of the application of a rule to a game, together with an indication of the need to take into account a rule’s domain of application. The “rules of the game” Einstein is speaking of are just what we would call Wittgensteinian rules of language.

Relational Interpretation of Quantum Mechanics and Contextual Realism

In theory, there's no difference between theory and practice. In practice, there is. (Yogi Berra; quoted in Criel 2019.)

1. Introduction

In this chapter we offer a contextual-realist interpretation of one of the most influential contemporary interpretations of quantum mechanics: Carlo Rovelli's relational quantum mechanics. The fundamental point is to understand correctly the concept of reality, and to take into account the categorical difference between the ideal (concepts, theories, observers) and the real (the application of theory, real objects, observed systems). The consciousness (subjectivity) of the observer plays no metaphysical role within our interpretation. The approach we propose can also be understood as a return to the Copenhagen interpretation, adjusted within the framework of contextual realism. In our view, later interpretations of quantum mechanics have generally been worse than the original interpretation of the founders of quantum physics. Contextual realism makes it possible to get rid of the metaphysical problems faced by various interpretations of quantum mechanics, including the relational one – to give a non-metaphysical interpretation of the quantum event that occurs when a physical quantity is measured, as well as a realist and local interpretation of quantum correlations.

It is important to recognize that no matter how far phenomena transcend the scope of classical physical explanation, the account of all evidence must be expressed in classical terms. (Bohr; quoted in Bell 1975, 1987; see also Bohr 1951.)

We accept Bohr's position, so understood. "Evidence" is the evidence of a phenomenon within which both a classical object and a quantum one can be given (in the latter case, the phenomenon may conventionally be called "quantum"). The phenomenon itself, however, is fixed in classical terms. This is a definition we find already in Plato and Aristotle: Plato realized that a "phenomenon" involves the difference between appearance and reality, and hence has a normative dimension.³⁹ It presupposes a judgment made according to the norm (rules, concepts) by a "classical" subject. If the judgment is correct, appearance corresponds to reality. Aristotle developed the concept of the phenomenon further: for him, a phenomenon is always the phenomenon of someone, at some point in time, in some way, and under some conditions (Benoist 2017). In Wittgensteinian terms, we will say that a phenomenon is a norm/rule-governed "language game" within which the real object is identified (Pris 2018a, 2018b).

In quantum physics, the role of norm/rule is played by quantum theory, and the role of the quantum phenomenon is played by the application of that theory (Pris 2014a, 2014b, 2018a, 2018b). The theory does not apply by itself: it is applied by the subject, "the observer." In particular, the observer prepares the conditions of a quantum experiment, observes quantum phenomena, and measures quantum physical quantities. This does not, however, mean that quantum physics involves the presence of a subjective element, or of "consciousness" in the sense of some non-physical substance. The term "observer" means only that there is an application of concepts – quantum as well as classical, ordinary concepts, since quantum concepts are, in part, generalizations of classical ones, and presuppose them (Pris 2012). Concepts are developed in reality, but they are not themselves real; they belong to the category of the ideal.

We can speak of the "reality" of concepts (norms, intentions, meanings) only in the sense of their authenticity, if they are genuinely authentic – not pseudo-concepts – that is, in the sense of their being rooted in reality, in context, or in the sense that there exist real conditions for their application (Benoist 2010).

³⁹For the Stoics, who opposed Platonism, the fundamental reality is feeling, not ideas. Feelings can be authentic or unreliable, but they are not, in themselves, deceptive: appearance can mislead us only because our judgments about our sensations may be false (Russell 2018: 429). This position comes close to the normative (and realist) interpretation of Platonism, on which (ideal) norms measure reality (Benoist 2016), between which and the perceived there is no distance (in the sense of *le sensible*; Benoist 2013). It is accordingly no surprise that, as Russell notes, the early Stoics were materialists, though they later departed from materialism under the influence of Platonism (Russell 2018: 403).

The nature of a given physical reality is revealed in the concepts that allow it to be captured – described, explained, presented. A peculiarity of quantum theory is that its physical quantities are non-commuting operators. This generally prevents them from being assigned simultaneous exact values, renders them discrete, probabilistic, and observer-dependent. The Kochen–Specker theorem, which complements Bell’s theorem (Bell 1964), shows that, owing to this non-commutativity, quantum mechanics cannot admit context-independent measurements of hidden internal parameters of physical quantities possessing determinate values at every moment (Kochen 1967).

The dependence of the values of physical quantities on the observer is emphasized by Carlo Rovelli’s relational quantum mechanics (henceforth: RQM; Rovelli 1996, 2016, 2018). We shall argue that the best way to interpret it is a contextual one, in the sense of contextual realism.

RQM rejects the absolute character of quantum events, of the state of a quantum system, and of its properties: a quantum event, or a sequence of quantum events, the wave function of a quantum system and its properties, are defined only from the point of view of this or that observer; it makes no sense to speak of them in the abstract. On this view, the wave function is not “real,” but plays a purely instrumental role, that of a “ledger” containing information about the quantum system available to a given observer. That is, the wave function is information about the system relative to the observer; the “reduction” of the wave function means a change in the information the observer has, not a transformation of reality. For Rovelli, individual quantum events, registered here and now by a given observer, are real: they arise as a result of the interaction of quantum systems, exist only within interactions, and are relative – real only in relation to the system involved in the interaction. “Interaction” is, for Rovelli, a primitive notion; all systems, observers and macroscopic systems included, are, on this view, equally physical systems. RQM further holds that reality is internally relational, and that quantum mechanics describes the relations among quantum events; the existence of “internal” (absolute) properties that do not depend on interaction between systems is rejected in favor of relational properties. For Rovelli it makes no sense to speak of the state of an isolated system, because the physical world is a network of interacting components (Laudisa 2007). It is relations, not “objects,” that constitute the basic ontology of quantum reality.⁴⁰ Rovelli, too, treats this relation as an informational one.⁴¹

⁴⁰Candiotto holds that quantum relationalism is a kind of “ontic structural realism,” one that asserts the primacy of relations and the secondary nature of objects (Candiotto 2017). Van Fraassen interprets RQM as an “information structural realism” (Van Fraassen 2010).

⁴¹An important aspect of RQM is that the theory is derived from theoretical and informa-

RQM faces the following objections. RQM holds that different observers may give different descriptions of the “same” sequence of events – which, one would think, ought therefore to be absolute; yet RQM equally maintains the absolute character of the relation itself. Both claims sit uneasily with the overall relational framework of the approach. Moreover, the relations in question are naturally understood as arising from the interaction of systems – but since it is precisely relations among interacting systems that are said to have primary ontological status, the question arises of the reality of the interacting systems themselves. Can we speak of an interaction between systems that are not themselves real? And how could a relation exist without the existence of the relata that enter into it?

Bitbol rejects this residual absolutism (a “naturalization aporia”) in RQM. For him, the poles of a relation should themselves be treated, according to the logic of the relational interpretation, as products of prior constitutive relations. Bitbol proposes moving from a naturalistic standpoint to a transcendental one, replacing interacting physical reference systems with functional reference systems, formed by relations (Bitbol 2007, 2010).

If, however, we confine ourselves to a neo-Kantian standpoint, we must grant that RQM is a form of correlationism, and, as a consequence, that it denies the cognizability of things themselves. A genuinely realist position, by contrast, asserts the possibility of knowing things themselves, not merely things-for-us.

We criticize Rovelli’s approach on the basis of the categorical difference between the ideal and the real that we accept within contextual realism (Benoist 2017; Pris 2018a, 2018b). For Rovelli, the interaction of physical systems produces real events, and information is likewise exchanged through interaction. In our view, this involves

tional postulates. This was the impetus behind the development of informational approaches to quantum mechanics, and, in particular, quantum Bayesianism (Fuchs 2001–2018; von Baeyer 2016). (An operational approach that reconstructs quantum mechanics as a system of quantum bits, based on elementary rules for the acquisition of information, is proposed in Höhn 2014, 2018; see also the critique of the theoretical-informational approach to the quantum system as a set of questions that can be posed about the system in Wood 2010.) Quantum Bayesianism has something in common with our own approach, in that it treats quantum theory as a system of rules for interacting with “reality.” In particular, quantum Bayesianism assigns the Born rule a normative rather than a descriptive role. Our approach, however, remains realist: for us, theory is a Wittgensteinian rule (norm), one that is rooted in reality in the sense in which Wittgenstein’s rules, norms, and concepts are defined within the framework of a “form of life” (Wittgenstein 1953, 2001).

a mixing of categories: information, like knowledge, belongs to the ideal category (information and knowledge are information and knowledge *about* something real), whereas the interaction of physical systems is itself something real. It is another matter if, by “interaction,” we mean the exchange of information – that is, not the perturbing physical interaction, but the “dimension” carried out by the subject. Indeed, some authors point out that, since Rovelli treats interaction as a primitive concept, it cannot be analyzed in causal terms.

Leonard Susskind argues that the Copenhagen interpretation of quantum mechanics – which assumes a single external observer and the collapse of the wave function – and Everett’s interpretation – which introduces a multiplicity of observers but no collapse – offer descriptions that are, in a sense, dual to one another (Susskind 2016).

Bitbol sees Bohr’s and Everett’s interpretations as two extremes: Bohr tends to focus on specific quantum phenomena (“phenomena”), while Everett’s is an abstract, theoretical construction. The first is instrumentalist; the second, “realist.” Everett’s abstract version of quantum mechanics is autonomous with respect to actual laboratory events. (Everett himself saw his approach as intermediate between Bohr’s and Einstein’s.)

Rovelli believes that his approach makes the Copenhagen interpretation of quantum mechanics more democratic, by treating all physical systems equally (Rovelli 2018).⁴² Our own approach, in a sense, also suggests a return to the Copenhagen interpretation, adjusted within the framework of contextual realism, which draws a categorical distinction between the normative (theory) and the real (the application of theory). In particular, the contextual approach gives a non-metaphysical interpretation of the quantum event that occurs upon the measurement of a physical quantity (Bitbol 2015: 320); this in turn allows for a realist and local interpretation of quantum

⁴²One of the motivations behind RQM is quantum gravity. Since general relativity is itself a relational theory, constructing a quantum theory of gravity plausibly requires a relational interpretation of quantum theory as well. Within Rovelli’s loop quantum gravity, the relationalism of general relativity is combined with the relationalism of quantum mechanics, and the only reality is that of events happening here and now (Rovelli 2018). It should also be noted that a close connection between quantum mechanics and general relativity has recently been established: Vidotto, for example, shows that a quantum physical system can be identified with a region of space-time (Vidotto 2013). Leonard Susskind, too, has written about the close connection – perhaps even identity – between quantum entanglement and gravity; in particular, there is an equivalence between quantum entanglement (quantum correlation) and spatial connection between black holes through wormholes (Susskind 2017).

correlation.

2. Relativity to Quantum Reality

Classical reality is usually treated as absolute: tables, houses, and trees, for instance, are believed to have “internal,” absolute properties, which they retain regardless of point of view. According to Rovelli’s relational interpretation, by contrast, quantum reality depends on the physical system that interacts with a given system and thereby plays the role of observer.

Consider, for example, an observer P who observes a measurement of some physical quantity A , made by observer O on system S (so that O interacts with S), but who does not himself interact with the composite system $S + O$ (i.e., does not perform a measurement on it). The wave function of the composite system will, for P , be entangled, and so the value of the physical quantity A of system S will, for P , be indeterminate, while for observer O this value will be determinate. That is, as Rovelli puts it, “the same sequence of events” can be “described differently”: two different observers see different things.

Rovelli interprets this situation as showing the relativity of quantum reality (ontology) and of the values of physical quantities. On the one hand, quantum ontology is poorer than classical ontology – consisting only of what is really measured, here and now: quantum events, and the relations among them; on the other hand, it is relative.

Within relational quantum mechanics, the wave function is not an absolute notion: in itself it does not describe (does not represent) the state of the quantum system, understood as some absolute quantum substance (“actual stuff”). It depends on the observer, and encodes the information available to that particular observer (Rovelli 1996, 2018).

The wave function Ψ plays an instrumental role: it establishes links between the values of physical quantities.⁴³ Rovelli writes: “Quantum mechanics is not about

⁴³One obvious objection to the “reality” of the wave function is this: if the wave function were a real quantum state, how would its instantaneous collapse be possible – that is, how could one physical state (one physical reality) instantaneously collapse into another possible

‘quantum states’: it is about the values of physical variables” (Rovelli 2018, “Space is blue and birds fly through it”). This has a positivist ring to it. From a realist point of view, the values of physical quantities refer to something real (they are not, by themselves, mere numbers), and any information is, by definition, information about something. As Schrödinger writes, “*personne ne perçoit deux mondes, un monde observé et un monde ‘réel’*” – “no one perceives two worlds: the observed world and the ‘real’ world” (Schrödinger 1982: 108).

Rovelli also writes: “The physical theory is concerned with relations between physical systems. In particular, it is concerned with the description that observers give about observed systems” (Rovelli 1996: 1955). A relation between physical systems, however, cannot exist if there are no systems that enter into that relation; and descriptions (if they really are descriptions) describe something – descriptions of observed quantum systems describe those quantum systems. What has been said pertains to the “grammar” of the notions of “description,” “attitude.” At the same time, the poles of a relation can be treated, not as independent of the relation and external to it, but as constituted together with it. This is how Bitbol proposes we interpret RQM (Bitbol 2007). The neo-Kantian approach here is a kind of “correlativism,” one that rejects the existence, or at least the knowability, of any reality beyond the correlative relation.

A realist philosophy of quantum mechanics should aim to understand the nature of quantum reality. A quantum state, for example, can be pictured as a kind of dispositional background, described by a wave function. Rovelli’s position does not seem to us to conflict with this view of the nature of quantum reality; it should only be noted that the dispositional background, like the wave function, itself depends on the observer’s point of view – that is, a given quantum system cannot exist in isolation from the observer. More precisely, the part of it that does not depend on the observer, that is not identified by him, is simply not determinate. It is this “part” that can be described in many different ways. As a result of the “reduction” of a given wave function at the moment of measurement, relative to this or that observer, who measures this or that physical quantity, a certain determinacy arises. We will say that such a reduction amounts to a move into a particular context; we do not regard it as some sort of “outrageous” interaction. We hold, that is, that any description of a physical system, any identification of a physical quantity, is given within a certain context, relative to this or that observer. Different, specific quantum realities arise in different contexts.

one? This conflicts with the laws of physics, and in particular with special relativity.

The relativity of the quantum state, in Rovelli's sense, can, we believe, be explained by the example of the impossibility of cloning the wave function: only an observer who has prepared a wave function (the state of a quantum system) knows its state (Pris 2014, 2015). An intruder cannot know the state of a single quantum system, even if he interacts with it. Let us examine this issue more closely.

3. Wave Function and Quantum Reality

As is well known, the wave function suffers from a lack of objective reality, in the following sense (Haroche 2007). The wave function of a quantum system can be well defined within a statistical context, one in which it is possible to perform measurements on identical copies of the system. Where we are dealing with only a single instance of a quantum system, in the pure state ψ – which may be represented as the eigenstate (with eigenvalue 1) of some projector – the function ψ is known only to the experimenter who prepared it, and cannot be known to an outside observer. Indeed, as a result of measurement the system changes its state unpredictably and irreversibly; part of the information about the initial state is irretrievably lost, and the experimenter obtains only partial information about it. (A consequence of the wave function's lack of objective reality is precisely the impossibility of exactly copying, or cloning, an unknown state.)

One must therefore either accept the existence of a reality unknowable from the standpoint of an observer not involved in preparing the wave function, or accept that this reality itself presupposes the presence of an interacting observing subject: independently of the observer, the wave function cannot be regarded as objectively real; quantum reality just is the reality of the act of preparing the state of the system.

In this latter case, the concept "wave function" cannot be treated as a concept in the classical sense, but only as a "quantum concept," whose functioning presupposes the presence of an observer. Thus, in quantum theory, concepts do not function as a means of representing a metaphysical reality of objects existing independently of the observer, but as rules for the observer's interaction with reality, and for the formation, by the observer, of a derivative, classical "metaphysical reality." The "interaction" we are speaking of here should be understood as a "measurement" of (non-metaphysical) reality, within the relevant context (Pris 2014, 2015).

Within contextual realism, this secondary “metaphysical reality” is the reality of quantum objects identified within measurement contexts. By “quantum objects” we mean objects in a broad sense: any determinate (identical) entities identified with the help of quantum concepts – in particular, quantum physical quantities possessing determinate values within the context of measurement. The quantum system itself, understood as a dispositional background and described by the wave function ψ , is a certain reality, an object in a generalized sense.

4. A Critique of Metaphysical Realism

The relativity of the wave function, of physical quantities, and of events, is owed to the non-metaphysical picture of reality; we share Rovelli’s critique of metaphysical (“strong”) realism.

Let us briefly review the background. In their 1935 paper on an example of quantum correlation (the EPR paradox), Einstein, Podolsky, and Rosen showed that locality and strong (metaphysical) realism are incompatible with the completeness of quantum mechanics (Einstein 1935). In 1964, Bell showed that EPR correlations are likewise incompatible with a realist theory of local hidden variables (Bell 1964). On the strength of this result it was concluded that “local realism” is untenable. At the same time, it was established that quantum “non-locality” cannot be used to transmit energy or information – that is, it is compatible with special relativity. That is, the EPR paradox does not imply “non-locality” of quantum mechanics in the sense of an instantaneous transfer of interaction or influence.

Within relational quantum mechanics, locality – in the sense of the impossibility of an instantaneous transfer of interactions across a distance⁴⁴ – and the causal nature of quantum correlation are both preserved, at the price of weakening traditional (“strict”) realism, by setting aside the specifically quantum nature of the correlation. The “non-locality” of quantum correlation established by Bell is thereby reinterpreted as local – that is, as the existence of a common cause, within a non-deterministic context (Martin-Dussaud 2018). Quantum “non-locality,” on this view, is only an apparent effect (see also the local interpretation of quantum correlation proposed by Bitbol; Bitbol 2015, 2019).

⁴⁴The concept of (non-)locality is itself ambiguous (Martin-Dussaud 2018).

Rovelli rejects realism in the “strong” sense – the thesis that, just as in classical mechanics, one could, at some fundamental level, at every moment enumerate all the properties of the world and all the values of all the variables describing it. This is what is called “metaphysical realism.” (Realist in this strong sense are, for example, many-worlds interpretations of quantum mechanics, in particular Everett’s, as well as Bohm’s interpretation and other interpretations that introduce hidden variables.)

Within RQM, physical quantities have determinate values only at the moment of interaction between the observer and the observed system. Quantum ontology is thus poorer than classical ontology: there are no individual (constant) quantum objects with internal (constant) properties; it makes no sense to say that something happens between quantum events,⁴⁵ properties of quantum systems do not exist in the interval between their interactions. As a result, it is impossible to define an individual object at a point of space-time, or to characterize its properties so as to distinguish it from other objects: there are only properties of quantum events arising as a result of interactions. This raises the question of how a particular result gets updated on the basis of the predicted probability of possible results.

Within RQM it is possible to compare the values of physical quantities relative to different observers, but the accuracy of the comparison is bounded by Planck’s constant (Rovelli 2018). RQM holds that, in quantum mechanics, just as in general relativity, there is no consistent global point of view: quantum mechanics is a perspectival theory, and every point of view is partial. RQM likewise rejects monism, in the sense that one cannot speak of the quantum state of the universe as a whole (as, for example, Everett tries to do).

RQM rejects any privileged role for the observer. For Rovelli, “all systems are equivalent: nothing a priori distinguishes observer systems from quantum systems” (Rovelli 1996: 1644). According to Vernet, Rovelli’s relationalism can be seen as the discovery of the “incompleteness” of the description of reality given by any single observer – that is, the discovery of the “incompleteness” of the Copenhagen interpretation of quantum mechanics (Vernet 2006).

⁴⁵Unlike classical mechanics, quantum mechanics does not describe (spatio-temporal) events between measurements (though it does describe temporal events); such talk simply makes no sense. In particular, it makes no sense to speak of determinate quantum trajectories. A space-time quantum event occurs only when the position of the quantum particle is measured.

5. The Ambiguity of Rovelli's Position

In our view, Rovelli's critique of the privileged role of the observer is ambiguous. If it means that any physical system can play the role of an observer, and vice versa – that any observer can himself be observed – then we accept it. At the same time, one should not forget the difference in status between the observed and the observer: the former belongs to the category of the real, the latter to the category of the ideal. The measuring instrument is material, but qua measuring instrument it does not, by definition, play the role of reality; the “interaction” of the measuring instrument with the system being measured is not a physical process but a “contact,” as a result of which information is acquired. Thus an observer has a “privileged” status only in the sense that it belongs to a different category. This status itself depends on point of view: an observer can become something observed, and vice versa.

Thus, on the one hand, RQM eliminates the dualism of observer and observed, and the dualism between the classical or macroscopic system and the quantum or microscopic system; on the other hand, this is itself a naturalistic position. The categorical distinction between an observer, on the one hand, and the “act” of observation/measurement together with the observed system, on the other, goes unrecognized. While rightly rejecting the dualities of system/observer, quantum system/classical system, and physical system/consciousness (subject), Rovelli, at the same time, fails to take into account the categorical difference between the normative and the real, thereby naturalizing the normative (the ideal). The normative dimension of the observer is ignored.

6. Relationalism and Relativity

Rovelli compares quantum relationalism with relativity in classical physics (the analogy between quantum theory and the theory of relativity appeals also, for instance, to Everett). The speed of a particle, for example, depends on the reference frame, on the observer; similarly, Rovelli holds, quantum physical quantities depend on the observer.

It seems to us that this comparison does not always succeed. It needs qualification,

because quantum relationalism treats physical quantities as absolute, albeit relative to the observer – they cannot be established by another observer not involved in an interaction with the system being observed. For the same reason it is impossible, as it is in classical physics, to introduce some invariant, such as a velocity vector, that would have different “coordinates” for different observers. In classical theory, the components of a particle’s velocity depend on the reference frame, but the velocity vector itself is invariant; this invariant can be recovered from the velocity components in any coordinate system, and the procedure for measuring the velocity components is likewise irrelevant to the coordinate system chosen. In the theory of relativity, the invariants are four-dimensional tensors. This is not the case in quantum mechanics: quantum reality is pluralistic, allowing only a single description for each observer, one that cannot be compared with other such descriptions.⁴⁶

The situation seems to change if we interpret the relativity of speed within the framework of contextual realism: speed depends on context, on the reference frame, but, within a context, relative to a fixed reference frame, it is absolute. It is also possible, further, to consider the reference frame itself as a context, within which the values of speeds across different reference frames are compared. In this case, the speed values within each individual reference frame lose their absolute character and become relative.

Genuine realism, including a non-metaphysical (“weaker”) realism, cannot assert

⁴⁶This does not mean that RQM admits no invariants at all. Without invariants, physical processes could not exist; in particular, it would be impossible to identify the “same” sequence of events. The role of invariants in quantum theory is played by mathematical structures, and, in particular, by the wave function – which, in that sense, is “real.” It is real in the same sense in which the velocity vector is real. But unlike the classical reality of the velocity vector, which literally reflects the physical quantity of velocity – the direction of motion and the absolute value of velocity – the wave function is only “rooted” in quantum reality: only one of its components, in the decomposition into eigenfunctions of the physical quantity in question, literally corresponds to a reality that is realized as a result of a measurement of that quantity.

Van Fraassen identifies the following invariants within RQM: (1) each physical system is characterized by a set of questions that can be asked of it – in essence, a set of physical observables (or something reconstructed from that set); (2) the answers (“yes” or “no”) an observer receives to his questions about the system depend on the choice of observer, since they result from an interaction, an exchange of information between systems, but are absolute – not observer-dependent – for each fixed observer; (3) the probability of a positive (or negative) answer to a given question about the system is independent of the observer; (4) independence from the observer of “irrelevant” information (see van Fraassen 2010: 399–400 for further detail).

the relativity of reality, or of physical quantities as such; it can, however, assert the dependence of ontology and of physical quantities on context. “Relativity,” here, is relativity relative to the context in which the observer finds himself. Relativity, understood as relativity to an observer interacting with the system under observation, can give the impression that the initial state of the observed system has, as a result of the interaction, been perturbed, and can no longer be observed – that only its transformed state, the result of the interaction, is observable. In this sense, the system is observed in its own right, and the interaction has already, so to speak, been observed.

In other words – as we have repeatedly stressed – Rovelli does not draw an explicit distinction between the categories of the ideal and the real. For him, there is nothing distinguishing the observer system from the observed system. For us, the two differ in status (a status that is, itself, not absolute). If an observer is genuinely functioning as an observer, it cannot fall into the same category as the observed system: the latter is “ideal” – no, rather, the observer is “ideal,” and the system being measured is real. But the very status of the system depends on point of view.

7. Relationalism and Correlationism

It seems to us, then, that Rovelli’s critique of metaphysical realism is dressed up in idealist and naturalist garb at once, so that relationalism risks being mistaken for correlationism – the view that we have “access” only to the correlation between subject and object, not to the object and the subject themselves; only to the interaction (correlation) of observer and observed, not to the observer and the observed as such; only to things already conceived, not to things and thoughts as such; only to interacting systems, not to the systems themselves, and not to “isolated” systems. Correlations (in Rovelli’s “interactions” between physical systems) are, on this reading, the only thing that really exists. It should be noted that Rovelli does not, in fact, introduce a subject as such: the role of observer, for him, is simply played by a physical system, and all systems are equal – each can play the role of an observing system, or that of an observed one.

It is, however, impossible to do without the concept of the subject – though this does not mean that the interpretation of quantum mechanics must be subjective. Within the

framework of contextual realism, the subject is “desubjectivized”: it is understood as a “movement” (the application of concepts, norms, rules) within reality, which is developed in reality itself. Any measurement of a physical quantity made “here and now” may turn out one way or the other, true or false – that is, any measurement of a physical quantity is a phenomenon. The phenomenon is the subject. This does not mean that the subject, consciousness, somehow affects objective quantum processes, but rather that the phenomenon has a normative (conceptual) dimension.

The naturalistic character of Rovelli’s approach, and its mixing of categories, shows up clearly in his treatment of the notion of information. Rovelli holds that there is no distinction to be drawn between a physical system, an observer as a physical system, and an observed system; he holds that quantum “nature” just is the information an observer acquires. But the concept of information is not itself naturalistic: it involves the use of language, of concepts, and these are used by a subject. For Rovelli, an exchange of information is a quantum-mechanical interaction, an act of measurement performed by the observing system on the observed system. But interaction, in itself, is not an exchange of information – it is simply part of reality (Vernette 2006).

Correlationism is overcome by a therapeutic, deflationary approach based on a careful distinction between the ideal and the real, norms and real things (Benoist 2017). We apply this approach to the philosophy of quantum mechanics. Any physical system can play the role of observer; at the same time, it thereby takes on a special status. It can no longer belong to the category of the real, and hence cannot be regarded as interacting – in the sense of a perturbing interaction – with the system being measured. As noted above, the interaction between observer and observed system can only properly be spoken of as a “contact,” without which measurement is, of course, impossible. We are, again, speaking of measurement in context: entering a context is not some outrageous interaction, but a measurement of a thing as it is, regardless of the measurement.⁴⁷

⁴⁷So-called “interaction-free measurements” have been studied. It turns out that the result of a measurement performed on a quantum system by a device with which only part of the measured system interacts has the same effect as a measurement made by a device that interacts with the whole (Elitzur 1993; Dicke 1981; Bitbol 2019: 266). According to Bitbol, “(...) the first decisive lesson is that a suitable criterion for determining the measurement results is not some ‘material’ connection of the system with a part of the device, but an informative connection with the global structure of the device. (...) The second decisive lesson: in quantum experience, what matters is not the hypothetical process taking place between preparation and detection, but its informative relation to the *final configuration* of the measuring instrument, which can be fixed almost at any moment prior to that detection” (Bitbol 2019: 266).

8. RQM in Terms of the Categorical Difference Between an Observer and What Is Observed

Let us return to the situation described above, involving systems S , O , and P . In fact, system O , considered as a measuring instrument, belongs to the category of the ideal. In this case one cannot say that it interacts with system S in the sense of a perturbing interaction. It “interacts” with S , of course – it comes into contact with it – but only insofar as it plays the role of a measuring device, which, by definition, does not disturb the system being measured, but measures it, measuring the value of the physical quantity A associated with that system. In this sense a quantum instrument is no different from a classical one.

At the same time, the act of measurement – the subject’s use of the measuring device – is a real, pragmatic, practical act, an action. To use O as a measuring instrument is to actually use it, to actually measure with it. In this sense, at this stage, we are dealing with reality and the real things being measured, whereas prior to measurement we were dealing with system S only theoretically, in terms of the abstract quantum theory and the wave function describing the state of S . At the same time, the status of the ideal is attributed here, not to system S , which is real, but to quantum theory (theory being real only in the sense of being rooted in reality, and also in the sense that it corresponds, in some minimal sense, to a certain reality – a dispositional reality).

For example, the result of a photon–electron interaction can be measured either at the moment of the interaction, or immediately afterward, or some time afterward, by measuring the position or momentum of the scattered photon. It turns out that the result is the same regardless of the timing of the measurement. Consequently, if one assumes that, at the moment of measurement, there is an interaction between the device and the quantum system that, depending on the choice of device, leads to different results, one is forced to assume that, where the measurement takes place at a later time, the device has a causal influence on the past state of the electron.

In fact, it would be more accurate to say that everything happens *as if* measurements made in the present had a retroactive effect on what happened in the past. Everything looks *as if*, in the present, the experimenter could change the past state of the electron at will.

This paradoxical appearance arises within the framework of metaphysical realism. From the standpoint of our own contextual realism, the result of the interaction has no determinacy until it is measured. But a “dimension” is not an interaction that transforms one state into another; it is a simple, non-disturbing (by definition) dimension that is, however, possible only in one context or another. The result of a measurement is not an interaction, but a transition to a particular context. In this case, the fragment of reality in question becomes more determinate.

System S is real, and possesses whatever determinacy it has – the determinacy encoded by the wave function, which encodes the probabilities of the possible results of measuring the relevant physical quantities.

Observer P , by contrast, does not interact with the composite system $S + O$ (and hence does not interact with either S or O). For him, system O has the status of a real physical system (not that of an ideal measuring instrument), interacting with system S . At the same time, the theory describing this composite system – that is, quantum mechanics and the wave function – belongs to the category of the ideal. By hypothesis, observer P does not himself enter the pragmatic, practical domain of real measurement; his status is accordingly not the same as that of O , once O has made a real measurement and obtained a determinate value for the physical quantity A . A comparison between P and O becomes possible only if P , too, performs a real measurement, on the composite system $S + O$ – but in that case observer P obtains the same result as observer O (assuming O has already measured). In this sense, there is no dependence on the observer at all. The “relativity” Rovelli speaks of is the result of a mixing of the categories of the real and the ideal.

“Relativity” should be understood as contextual, in the following sense. Quantum ontology, and the values of physical quantities, are not absolute but context-specific. A quantum state is a dispositional state; quantum-system ontology (quantum ontology) is a dispositional ontology – a certain slice of reality possessing a dispositional, probabilistic determinacy. This determinacy is weaker than the classical determinacy of visible material objects; this allows it to be fixed within one context of measurement or another – that is, within the context of applying quantum theory as a norm. Updating from one possibility to another is not the collapse of a dispositional reality into another reality, but a transition to the context of measurement. (Perhaps it is not quite correct to speak of a quantum “dispositional reality” at all: what is at issue is a minimal reality, specified by means of the wave function, rather than a dispositional one. If the wave function represented some absolute – even if dispositional – quantum reality, the question would arise how, as a result of the reduction of the wave function, this reality could instantly turn into another reality.)

In fact, the reduction of the wave function corresponds to the transition into the context of the theory’s application, within which the reduced wave function alone exists. Contextual realism is not metaphysical realism. In this sense Rovelli is right: the metaphysical concept of reality must be weakened. In this sense, the wave function is not real, does not represent reality – as noted above, an observer cannot clone the wave function of a single system he did not himself prepare. So the wave

function simply does not exist in relation to him. The wave function can be called a tool for predicting quantum phenomena. This, however, is not pure instrumentalism: the wave function, to use Wittgenstein's example, is rooted in reality, like a recipe for cooking.⁴⁸

9. Quantum Correlation in Context

We interpret the EPR correlation, which Smerlak and Rovelli read from the standpoint of relationalist realism (Smerlak 2007). For Smerlak and Rovelli, "in the context of the EPR debate, realism is understood as the assumption that, in Einstein's words, 'there is a physical reality independent of verification [and] perception'" (Einstein 1950). In fact, this statement is ambiguous. If Einstein's words are understood in the sense that there is a predetermined reality with an intrinsic meaning, properties, structure, and so on, then the criticism is correct. But if they are understood in the

⁴⁸Wittgenstein (see *Nachlass*, Manuscript 160) points to the existence of two kinds of rules, differing "grammatically" – that is, logically, in a broad sense: the rules of chess belong to the first kind, the rules of cooking to the second. Nothing in reality corresponds to the rules of chess: they do not reflect the nature of chess pieces, which have no nature independent of them; they do not describe the game of chess, but constitute it. In this sense such rules have no "nature" of their own. The rules of cooking and roasting, by contrast, "must be appropriate to the nature of the meat"; they have real conditions of eating, without which the purpose of cooking would not be achieved (see the quotation and discussion in Benoist 2017: 129). The reality in which they are rooted imposes constraints on the choice of such rules. The correspondence at issue here, however, is not a mutual correspondence between wording and "external reality," not an isomorphism. In a generalized sense, nonetheless, one can say that such rules "reflect" (or describe) the nature of the food.

It is precisely the rules rooted in reality – the rules of cooking, or, for example, context-dependent epistemic or linguistic rules, that is, rules that incorporate elements of reality – that Wittgenstein calls "grammatical rules," which possess a relative autonomy, unlike purely instrumental rules detached from reality. Purely functional rules, similar to the rules of chess, can be regarded as a limiting case.

All this applies to understanding quantum mechanics as a Wittgensteinian rule (henceforth: c-rules) – a quantum Wittgensteinian grammar (Pris 2014a). Quantum rules, which include quantum theory and, in particular, the concept of the wave function, correspond, in a generalized sense, to the nature of quantum reality, which is not a metaphysical, object-like reality located "opposite" its description by quantum theory.

sense that reality as such does not depend on verification and perception (in the sense of sensory perception), then Smerlak and Rovelli's critique amounts to accepting an anti-realist position.

Smerlak and Rovelli continue: "We call this assumption 'Einstein's realism.' RQM departs from this strict realism. RQM holds that physical reality is constituted by individual events (facts) in which interacting systems (objects) affect one another. Thus it is assumed that quantum events exist only within interactions, and – this is the central point – that the character of each quantum event is defined only relative to the system involved in the interaction. In particular, the properties possessed by a given system *S* are defined only with respect to the physical system *A* that interacts with *S* and by which these properties are affected."

In our opinion, the ambiguity of Rovelli's position remains here too. The distinction drawn above, between the ideal and the real, is not made. In terms of contextual realism, reality is what it is: it does not depend on verification or perception. (There is no distance between unconceptualized perception itself and reality; Benoist 2013.) In this sense, Einstein is right. Smerlak and Rovelli themselves note that Einstein's own position is not metaphysical, is nuanced, and contains not only a "realist" but also an instrumentalist aspect.⁴⁹

Moreover, as regards the concepts of "fact" and "object," Smerlak and Rovelli appeal to Wittgenstein's *Tractatus* (§§ 1.1, 2.01, 2.011, 2.0121) – though it is well known that the later Wittgenstein criticizes the traditional realist position adopted in the *Tractatus*.

Critical remarks on Rovelli's "realism" are likewise made by Vernet (2006): "It seems that Rovelli's approach fails to clarify two concepts: physical quantity and physical reality. As we have seen, for him, the relation between systems is fundamental. The mathematics of relations is the real problem. One naturally asks: 'The mathematical law of what?'"

As Bitbol notes, on Rovelli's view different observers have no common ground on

⁴⁹Note also that Arthur Fine describes Einstein's position as a "natural ontological attitude," which, from Michel Bitbol's point of view, bears certain similarities to (and differences from) Simon Blackburn's quasi-realism (Fine 1986; Bitbol 1994; Blackburn 1981, 1993). This latter position can also be read as Wittgenstein's own (Blackburn 1981: 172). The combination of "participatory modal realism" and quasi-realism, close to our own understanding of contextual realism, is proposed in Bitbol 2015.

which to compare their measurements; hence, despite differing results, no contradiction between them is possible (Bitbol 2010).

Bitbol and Rovelli, together with co-authors, hold that EPR correlations can be interpreted without introducing the concept of non-locality: Smerlak and Rovelli speak of a “non-deterministic (as opposed to classically deterministic) causal correlation.” “Non-locality” obtains only in the sense of a departure from classical deterministic locality; quantum mechanics is local and complete, unless one demands that it be absolutely ontological. Thus, within RQM, locality is not disturbed (Smerlak 2007; Martin-Dussaud 2018).

One might ask: relative to which observer does the statement about an instantaneous influence between *A* and *B* make sense? Not relative to *A*, since, at the time and place at which the measurement is performed, *A* has no access to the measurement made by observer *B* – and vice versa. The claim of correlation is retrospective: it refers to an observer who has taken the time to compare the measurements made by *A* and *B*. There is accordingly no non-local influence – no influence occurring at the same time as the measurement (Bitbol 2010; see also Bitbol 1983).

10. Contextual Realism of the Wave Function, Instead of Anti-Realism and Metaphysical Realism

RQM has certain affinities with Everett’s interpretation of quantum mechanics. Rovelli tries to find a middle ground between the instrumentalist Copenhagen interpretation and a realist interpretation of quantum mechanics; Everett himself claims that his theory constitutes a “bridge” between the positions of Bohr and Einstein (Everett 1957, Dissertation: 117).

At the same time there are also significant differences. As noted above, for Rovelli the wave function plays a purely instrumental role, whereas for Everett the wave function is real – indeed, Everett proposes treating the entire universe as a universal wave function subject to linear evolution. On this view the laws of physics are treated as internal correlations (Everett 1957, Dissertation: 117–118). Along with Rovelli, we reject Everett’s monism.

Within RQM – though not within many-worlds interpretations of Everett’s type – the

observer and the observed system genuinely interact. Within RQM there are real quantum events observed by each observer “here and now”; these events are relative, but for a fixed observer they are objective. Within many-worlds interpretations, by contrast, decoherence is brought in to do the relevant work; but since it preserves the entanglement of quantum states, it fails to explain why a particular measurement outcome occurs for a given local observer.

For Everett, the probabilistic aspects of quantum mechanics arise only at a subjective level, as phenomena tied to observers. It is argued that statistical assertions are not independent hypotheses but are derived from the wave mechanics itself (Everett 1957, Dissertation: 119). Considerable work, as is well known, has gone into deriving the Born rule from the quantum formalism by means of decision theory (Deutsch 1999; Wallace 2010, 2012); in our view, however, such derivations face serious difficulties, and there is at present no consensus on whether they succeed at all.

For us, the wave function (together with quantum theory) is a rule-instrument rooted in reality, like the recipe for cooking discussed above (Wittgenstein’s example). This is a contextual “instrumental realism,” one that recognizes quantum “beables” – elements of reality (the term is Bell’s; Bell 1975, 1993: 174).⁵⁰ A “realist” many-worlds interpretation and an anti-realist instrumentalist interpretation are two extremes. It seems to us that Rovelli combines realism and instrumentalism somewhat mechanically, since, for him, the wave function is a pure predictive tool. What is needed, instead, is to understand how the wave function is rooted in reality.

11. Quantum Interaction and Measurement

Brown points out that, within RQM, the notion of interaction is primitive, and cannot therefore be analyzed in causal terms, as though there were some causal process between system *S* and observer *O*: the fact is simply that certain values are obtained

⁵⁰ Bell formed the term “beable” from “be-able,” contrasting it with “observ-able” (Bell 1993: 174). For Bell, beables are the fundamental, authentic elements of reality in space-time – primitive ontological posits. “Beables” include the macroscopic conditions under which a quantum experiment is prepared, and the data obtained in measurement. For Bell, “beable” also means “physical,” as opposed to “non-physical” (Bell 1975). It is clear that a fully realist interpretation of any theory should be built on the basis of beables.

as a result of measurement (Brown 2009). We agree.

At the same time, Brown holds that a residue of “dualism” is needed to explain the transition from superposition to a determinate observed result: a dualism between the linear evolution of the entangled wave function and the determinate, relative property observed as a result of measurement (Brown 2009).

We reject this dualism. All dualisms, in our view, are overcome by the “rootedness” of the ideal in the real (in context), of theory in reality. (A “dualism” of categories is not a dualism at all – on the contrary, it does away with dualism, which arises from interpreting heterogeneous notions as belonging to a single category.) This means that the “transition” to an observed value is not a real transition at all: an observer simply discovers that he or she is in a certain context, and registers a certain value of a physical quantity, whereas beforehand the situation was indeterminate. In this sense the observer gains information – but this is not “pure information”; it is information about (within) its context, that is, about the real state of the quantum system in that context.

So, from our point of view, this is not a true dualism, but a “dualism” of the ideal and the real, the theoretical and the pragmatic. Recognizing this categorical difference does away with any genuine dualism. For us, “relativization,” or indexing, just is contextualization: it is a way of avoiding contradictions between two descriptions of the same process. Observer *O* and observer *P*, describing the interaction between *O* and *S*, do not describe the same (determinate) quantum reality, but different (determinate) quantum realities – that is, the initial situation, prior to description, is not itself fully determinate.

In Brown’s terminology, observer *P* sets a new boundary between system and observer; the state and properties of the system will accordingly differ for him. In our own terminology, the observation is made over a different system: $S + O$. The boundary Brown speaks of is a boundary between categories – the boundary of the real.

Brown argues that, for Rovelli, correlated objects (*relata*) are defined, but are defined in absolute terms, and relative to the relation itself; one cannot therefore say that there is no determinacy at all – it depends on the boundary drawn between system and observer (Brown 2009). In our view, this determinacy of the correlated objects should be understood, not in the sense of objects generated by an inner relation, but in the sense of real objects detectable within a context in which it makes sense to

speak of a given observer as well. The observer does not constitute a quantum object, but provides a means of its detection.

12. Mermin and RQM Correlationism

Rovelli's position should be distinguished from that of Mermin (Mermin 1997), which is genuinely correlationist: Mermin claims that there are only correlations (relations), and not correlata – correlated entities. Jeffrey Barrett describes this position as follows (Barrett 1999: 217; quoted in Brown 2009): “Correctly understood, physics is about correlations, and only about correlations. It is not about correlations between certain physical registrations, nor about correlations between some other certain physical properties. It is about correlations without correlata. According to Mermin, ‘correlations have physical reality and what correlates does not.’”

Barrett rightly criticizes correlationism, pointing out that relations without the entities that enter into them cannot exist. He holds that Rovelli's view is similar to David Mermin's (Barrett 1999). This impression is understandable, but a closer look shows that RQM, as noted above, is not a form of correlationism. We share Matthew Brown's view that Rovelli's position differs from Mermin's, because for Rovelli physical reality involves more than a bare relation: the interactions that result in determinate values of physical quantities are also real. These, too, are real, though relative – depending on the choice of observer, on the boundary between observer and observed. At the same time, once the observer is fixed, the physical values are absolute.

Brown points out that Rovelli distinguishes two types of relation: system–system and system–observer relations. The first are interactions between systems, which as a result may become entangled and quantum-correlated. The second is the interaction between a system and an observer, in which a system's property is updated for that observer. Observer *P*, observing system *S*, observing *O*, treats the relation between *S* and *O* as a system–system relation. The information observer *P* has about the system *S* + *O* therefore differs from the information observer *O* has about a particular value of a physical quantity (Brown 2009: 685). (Some critics of RQM also hold that the “interaction” of observer *O* with system *S*, in measuring a physical quantity, is the transmission of “information.”)

Brown's distinction between these two types of relation corresponds to the distinction we draw between the categories of the ideal, to which we assign the observer, and the real, to which we assign the observed system. It is clear that, for observer P , the system $S + O$, and hence subsystem O , are real; whereas, in the relation between S and O , the latter plays the role of the ideal – the normative.

Brown further argues that, for Rovelli, correlated objects (*relata*) are determinate, but determinate in absolute terms, and relative to the relation itself. Thus one cannot say that there is no determinacy at all; it depends on the boundary drawn between system and observer (Brown 2009). In our opinion, this determinacy of correlated objects should be understood, not in the sense of objects generated by an inner relation, but in the sense of real objects detectable within a context in which it makes sense to speak of a given observer as well. The observer does not constitute a quantum object, but provides a means of detecting one.

13. Relativity Is Not Relativism

One might suspect that relativity collapses into relativism. Within a thoroughgoing relativism, ontology generally disappears: the very concept of a real object disappears, since, by definition, an object involves the preservation of its identity.

Wood asks, for example, whether the existence (identity) of the electron, within RQM, is absolute or relative. If relative, the question arises whether there is an object at all; if absolute, the question arises how this is possible within RQM (Wood 2010).

Wood offers two possible answers. (1) A system is a set of questions that can be asked (that is, we are not talking about the system, but about the system *as* a set of questions); the set of questions determines the absolute identity of the “system.” This theoretical-informational approach does not seem viable even to Wood himself, since it is unclear how it is to be combined with the fundamental concepts of physics, and, in particular, with the concepts of space and time in which the system is located. (2) There is an absolute reality in which systems and observers see the systems differently. Wood says this contradicts RQM's own idea that everything is relative. The question also arises what that reality is: if RQM is correct, we cannot observe it, and therefore cannot understand its nature, since everything is relative.

From our point of view, the “system of questions” Wood refers to can be interpreted as a rule (a norm) for “interaction” with reality – more precisely, for measuring reality (within the framework of Fuchs’s quantum Bayesianism, we would speak here of the interaction of subject and reality). Such a rule is not separable from its paradigmatic applications – it is a “Wittgensteinian rule.” Any application of such a rule in reality is a space-time language game. This means that the theoretical-informational approach is compatible with fundamental physical concepts. Information itself has an epistemic dimension, not an ontological one. A purely “informational” interpretation of quantum mechanics is therefore impossible.

As for Wood’s second answer: from the standpoint of the contextual realism we adopt, it is not correct to raise the question of reality in the way Wood does. Reality as such has no nature; it simply is what it is. Both quantum systems, quantum observers, and specific quantum events resulting from measurement, are identified and fixed within a given context. Thus answers (1) and (2) converge on the same contextual standpoint.

Wood raises the problem of the trans-identity of the object: assuming the identity of the system is relative – that its very existence depends on the observer – the identity of any object seems to be lost.⁵¹

We understand dependence on the “observer” as dependence on context. The choice of rule depends on context; but, once fixed, the same rule applies across different contexts. The rule (as an invariant) plays the role of the (ideal) object: it is trans-identically preserved. It could not be otherwise – trans-identity is presupposed by the very notion of a rule.

For Rovelli, the points of view of different observers “should not be compared.” Wood writes: “(…) It seems paradoxical how any description of the world can exist if even the existence of objects depends on the observer. What do observers observe if the observer is ontologically prior to the object?”

⁵¹If quantum objects are relative, how do they combine to form absolute macroscopic objects? Wood turns to David Wallace’s use of Daniel Dennett’s concept of a “real pattern” (Wood 2010; Wallace 2003; Dennett 1991). Macroscopic objects are real “patterns” that are not directly represented in the formalism of quantum mechanics (Dennett 1991). This is consistent with contextual realism, if we interpret Dennett’s “real pattern” as what really exists within a given context. Wallace himself applies the concept of a real pattern in the philosophy of physics and, in quantum mechanics in particular, claiming that ontology depends on scale.

From our point of view, the norm (rule) precedes its new application, a new identification of an object, or the identification of a new object. In this sense, and only in this sense, is it prior to the object: we are speaking of a real (concrete) object as the exemplification (realization) of a norm/rule. The role of an abstract or ideal object is played by the norm (rule) itself. The ideal object is “real” only in the sense of its rootedness in reality. Quantum concepts play the role of ideal “objects”: they identify real quantum objects in one context or another. It is precisely the presence of a general rule that allows us to speak of an objective, observer-independent quantum trans-identity; and any particular (real) quantum object, though identified from a point of view – that is, relative to an observer – is not generated by the observer, but, as such, exists independently of him.

14. Conclusion: The “Democratization” of the Copenhagen Interpretation, and Contextual Realism

The Copenhagen interpretation of quantum mechanics is formulated in a language that refers to an observer: a quantum event does not simply take place, it takes place *for* an “observer,” whose role is played by a macroscopic system. A privileged system is thereby assumed: a classical (macroscopic) observer who does not obey quantum laws.

In our view there is a substantial grain of truth here: the observer (if it really is an observer) and the observed (if it is really observed) belong to different categories. In applying this distinction, the statuses “observer” and “observed system” are attributed within a context.

Already for Bohr, the epistemic (though not ontological) boundary between observed system and observer depends on context. In our view, a stronger statement can be made: the observer and the observed system can exchange their statuses. An observer can become something observed, and vice versa. In this sense all physical systems are on a par, and there is no privileged observer. But at the same time there remains always this categorical difference, which Rovelli overlooks.

One can agree with Rovelli that there is no need to introduce “subjective states of consciousness,” since any physical system can play the role of observer. Rovelli writes

(Rovelli 2018): “As soon as we relinquish this exception, and realize that any physical system can play the role of a Copenhagen ‘observer,’ we fall into relational quantum mechanics. Relational quantum mechanics is Copenhagen quantum mechanics made democratic by bringing all systems onto the same footing.”

Like Rovelli, we return to the Copenhagen interpretation, and hold that it must be correctly understood – corrected. Later interpretations were, in many respects, worse than the original interpretation of the founders of quantum physics (though, admittedly, these founders held different views, and the term “Copenhagen interpretation” characterizes the overall situation only roughly).⁵² In this case, unlike Rovelli, we accept a categorical distinction between the ideal observer (theory as norm, concepts) and the real (observable) system (the application of theory, the real object). This allows us to get rid of the metaphysical problems faced by various interpretations of quantum mechanics, RQM included.

String Theory, Quantum Mechanics, and Duality

The nature of physical reality, or of some fragment of it, is not definitively fixed as “quantum,” or as some other, more “fundamental” theory of all kinds of interactions. In one context it can be quantum, in another classical; and, in a third context, it can be “fundamental.” In borderline cases, the same empirical data can be interpreted, for example, both within classical theory and within quantum theory – and this means

⁵²Our proposed return to the Copenhagen interpretation, adjusted within contextual realism, can be compared to a return to the logic of the phenomenon. The concept of the phenomenon was introduced by Plato, who discovered that every phenomenon has a normative structure: a phenomenon involves the difference between appearance and reality (and it was in this way that Plato introduced the notion of being into philosophy). Appearance may or may not match reality. In the history of philosophy, the concept of the phenomenon has been subjected to distortions, truncations, and, in twentieth-century phenomenology, to absolutization and naturalization. For Kant, as for Plato, the phenomenon is not, in itself, anything at all in the object; it always occurs in relation to the subject, and is inseparable from that relation. Kant’s phenomenon also has a cause, but that cause is an unknowable thing in itself; Benoist describes the Kantian phenomenon as a “handleless phenomenon.” Auguste Comte’s phenomenon has no cause at all – Benoist calls it an “orphan phenomenon.” And so on. (For more detail, see Benoist 2016.) A proper understanding of “phenomenon” is necessary for a proper understanding of the “quantum phenomenon.”

that both interpretations are correct. That is, what we are dealing with are, in fact, not one but different phenomena, of different natures. (A relativist, by contrast, interprets the same phenomenon differently.)

In string theory, T-duality and mirror duality in the classical limit link empirically equivalent theories with different space-times (“target spaces”) – theories that differ, at least, in their classical limit. Within the full quantum theory, these dualities are theoretical (physical) equivalences. S-dualities link empirically equivalent string theories with various fundamental objects (Horowitz 2004; Dawid 2016; Matsubara 2018). The following questions arise: what do these theories say about the real (actual or possible) world, and what do they say about real (actual or possible) space-time? At first glance we are dealing with what philosophy of science calls empirical underdetermination.

Baptiste Le Bihan and James Read offer a classification of the different approaches to understanding this “underdetermination.” In particular, they consider the “common core” approach, the “encompassing theory” approach, and a pluralist approach (Le Bihan 2018).

From the standpoint of pluralism, the structures of each of the dual solutions of the different theories are treated as co-instantiated structures within the real world; in a sense, the physical world is fragmented (Le Bihan 2018).

Two problems arise here: (1) a theoretical (epistemic) over-determination (rather than empirical underdetermination): all the dual structures can be regarded as explaining (describing) the same empirical data; (2) an ontological problem concerning the consistency of the notion of a fragmented reality.

Our diagnosis is as follows: the assumption of metaphysical realism, which underlies all the approaches under consideration, pluralism included (so that we are really talking about a metaphysical pluralism), is false. The problems of over-determination and ontological fragmentation are consequences of this false premise; they are resolved, or dissolved, within the framework of contextual realism.

Benoist writes: “The norms, as I understand them, are my realism – they have no other purpose than to capture structures. And conversely: a structure is exactly what is grasped by a norm, when the norm is applied in the right way in the right context” (Benoist 2017: 106). In the case of string theory, this means that the pluralist position should be contextualized: what should be introduced is context-dependence, rather

than a fragmented reality.

In quantum mechanics, by comparison with string theory, the situation is in a sense inverse: one fully determinate structure – quantum theory (which we take to be complete) – corresponds to many different sets of empirical data (not predetermined measurement results, but rather the possible measurement results and their probabilities, which are predetermined). Instead of a theoretical “underdetermination,” there is an experimental over-determination. The many-worlds type of Everett interpretation can be seen as a kind of view on which the world is fragmented; but, as should be clear from what has been said, it is not different theoretical structures but different empirical data that correspond to the different “fragments.” As noted above, the best interpretation of Everett’s interpretation is a contextual, that is, pragmatic, one (a similar view is expressed in Bitbol 2015). This is consistent with the contextualization of the theory we have proposed above.

Within a unified perspective, the various aspects of string theory belong to a deeper M-theory that plays the role of a system of rules/norms: they are language games, that is, uses of rules in different contexts. The fundamental elements of the theory and/or its space-time (its ontology) are contextual; and perhaps there is also a context in which there is a single “fundamental” M-ontology and/or space-time. M-theory, on this reading, also plays the role of an “encompassing theory.” Thus, since realism is contextual, contextual realism and pluralism converge, allowing us to combine a pluralist approach with the “common core” and “encompassing theory” approaches.

Consider the following analogy. Von Neumann’s quantum mechanics is the general rule underlying both Heisenberg’s matrix mechanics and Schrödinger’s wave mechanics. Strictly speaking, the two mechanics are equivalent to one another only within the framework of von Neumann’s approach; within their own separate contexts, they can be interpreted as having different ontologies.

As for the concept of dual physical theories, numerous definitions have been proposed in the philosophy of physics (see, e.g., Castellani, forthcoming; de Haro, “The Heuristic Function. . .”); from our point of view, the most common definition is the following: duality is a (common) rule – that is, a family resemblance. In particular, equivalent physical theories are dual physical theories with the same physical content.

Thus, for example, we can also speak of wave–particle duality in quantum mechanics as a relation of duality: in one context the wave is a quantum-mechanical object; in another, a particle; and in a third, neither a particle nor a wave, but something

with the ontology of potentials, defined within the framework of the unifying von Neumann approach. In a broader context, the principle of conformity, understood as a rule, establishes a “duality” between classical and quantum mechanics themselves.⁵³

As for the classical limit of quantum theory, it is not always what one would expect on the basis of classical theory: that is, there is not always a continuous limiting transition. In quantum optics, for instance, a situation is possible in which the pressure exerted by light on a mirror inside an interferometer is explained, from the classical point of view, by the action of an electromagnetic field acting from outside, and, from the point of view of quantum optics, by photons inside the interferometer, as if pulling the mirror inward (Aharonov 2013). Thus, at the ontological level – taking into account causal “processes” and the spatial arrangement of matter – there is no limiting transition at all. We would argue that this is correct, because, in different contexts – classical and quantum – we are dealing with different ontologies (in particular, different causal “processes”). We cannot say that one ontology (context) is genuine and the other merely approximate, as though, strictly speaking, only one ontology could pass over into the other (even though there is no conceptual transition from quantum to classical).⁵⁴ We likewise decline to interpret the situation as a fragmentation of reality, unless “fragmentation” is itself understood as contextualization.

Within semiclassical mechanics the boundary between classical and quantum mechanics is vague, and one can even speak of semiclassical mechanics as a new theory in its own right: semiclassical methods mix classical and quantum ideas, and have their own domain of application. Classical mechanics, for instance, brings new insight to the dynamical structure of the helium atom; recently, semiclassical mechanics has been able to solve the problem of the helium atom in the spirit of

⁵³ Bitbol, by contrast, denies that quantum mechanics – and, in particular, wave–particle duality – reveals the deep nature of things: he holds that quantum theory is a “simple guiding method” for predicting phenomena (Bitbol 2019: 263). We agree, however, with Bitbol that quantum theory does not describe, does not represent, a ready-made, determinate, meaningful-in-itself world – that is, we reject traditional representationalism. In particular, there is no *a priori* particle or wave ontology.

⁵⁴ We can speak of a continuous limiting transition, for example, in the case of the simple reflection of light from a mirror: we can speak of the reflection of an electromagnetic wave, or of the reflection of a flux of photons, which is, as it were, a more accurate representation of the physical picture. In fact, it makes sense to speak of an approximation only within the language game of an inaccurate application of concepts, or of the application of concepts that are not quite suitable.

Bohr's old quantum theory (Bokulich 2008). Everything looks as if the applicability of classical concepts here had a stronger status than merely instrumental. And indeed, according to contextual realism, the correct application of a genuine concept within a context, as a result of which some object is identified, identifies the real object, the real thing itself.

There is no single, deep ontological essence lying beneath everything. For Benoit, what can be said to exist under given circumstances is a matter of "making ontology sensitive [to context]." Classical ontology differs from quantum ontology; and it appears that, at least in some cases, semiclassical phenomena may have their own specific ontology.⁵⁵ That is, the classical descriptions found in some semiclassical accounts, which use both classical and quantum concepts, are not always merely fictitious. Electrons moving in a synchrotron, for example, emit electromagnetic energy fully in accordance with classical electrodynamics, as if they were moving along trajectories; we can say that they really do move along trajectories (which cannot be said of their motion within the atom).

Contextual realism, as we understand it, holds that in the examples above there is a genuine variety of true phenomena and ontologies, which depend on context and have different natures. By shifting our point of view, we can move abruptly from one dimension of reality to another, in which there is no point in speaking of "the same," or even similar, things. The unity of physics, and hence of physical nature, allows not only for continuity and family resemblance, but also for discontinuities (Pris 2012).

⁵⁵In her book, Brigitte Falkenburg shows how the classical metaphysical concept of reality, and the ontology of particles, become increasingly unsuitable at ever smaller scales in high-energy physics (Falkenburg 2010). For her, "the principle of correspondence protects classical realism from a sudden disturbance in the quantum domain" (Falkenburg 2010: 193). In other words, it makes sense to speak of a continuous space of ontologies, among which there are family resemblances.

Conclusions About Quantum Mechanics

1. The wave function is not merely a predictive mathematical tool. In a generalized sense it is the cause of quantum correlations, the reality of which is contextual.
2. The classical dualism of “event” and “fact” (the description of the event) is rejected. The assumption that there exist predetermined (absolute, autonomous) events – of the type presupposed by talk of the “reduction” of the wave function as some real process – expressed in the language of the wave function and the Born rule, is accordingly rejected.
3. There is no need to explain the reduction of the wave function. If the use of the wave function and of the Born rule allows us only to identify (within the context of their use) this or that element of reality, as the result of a measurement procedure, there is no need to introduce into the picture the concepts of a real physical reduction process, or of an independent quantum event distinct from the fact of its being identified.
4. It is necessary to take into account the logical difference – the “gap” – between the rule (theory, the evolution of the wave function) and its application.
5. The well-known measurement problem in quantum mechanics is not solved, but dissolved: the “process” of measurement is not a real process. It is a mistake to think that, as a result of measurement, something happens regardless of the formalism of quantum mechanics, and is only subsequently expressed in the language of the theory. Independently of the means of identification, nothing happens – there is no phenomenon, no given.
6. The problem arises as a result of mixing the categories of the ideal (theory) and the real (its application).
7. Quantum theory, and the law of quantum probability, do not describe an autonomous, determinate reality independent of them. The correspondence between them is of the same kind as the correspondence between the rules for roasting meat and the roast that results: preparing an experimental situation is part of the application of the theory.

8. In a certain sense, it is the slice of reality in which a given (quantum) correlation occurs that is identified in context. As elements of reality, correlated events do not *arise*; they simply *are*. All that arises is their identification.
9. The Everett interpretation can be understood as introducing all possible contexts. If it is understood in the purely theoretical sense – as introducing a rule for measuring quantum reality – the interpretation is acceptable. Substantializing the rule, however – that is, the metaphysical many-worlds interpretation – is problematic (Pris 2016). Jocelyn Benoist calls this kind of approach a bad “baroque.” Kit Fine would say that, in this case, reality is fragmented (on the notion of fragmented reality, see Fine 2005); but, in our view, it is more correct to say that it is contextual. On a metaphysical-representationalist view, this fragmentation looks like a plurality of non-interacting (“parallel”) worlds.

Conclusion: The Problematic Nature of Traditional Epistemology and Realism

The study of the foundations of quantum mechanics, and of the nature of consciousness, within the framework of contextual realism, allows us to understand the source of the difficulties confronting traditional epistemology. The false doctrines that stand in need of correction are: the problem of access to reality; metaphysical representationalism; subject/object dualism; metaphysical epistemic realism; correlationism; and other such positions.

The traditional epistemological problem of the subject's (thought's, language's) access to reality presupposes a dualism of cognizing subject and cognized object, and, correspondingly, representationalism: the mental representation of the object functions as though it were a screen interposed between subject and object. The resulting position of realism, if accepted, turns out to be epistemic: what is real is whatever is available to cognition. Epistemology thus becomes primary, and ontology secondary – indeed, so to speak, drained of blood: the epistemic realist has no interest in things themselves, only in truth.

For Aristotle, by contrast, ontology is primary and epistemology secondary; and indeed, genuine realism just is ontological realism. Knowledge is generated within a reality of which the knowing subject is itself a part.⁵⁶ There is thus, from the outset, no “gap” between the subject and reality; the access problem is a pseudo-problem (see also Benoist 2011).

The subject is not a passive spectator of some predetermined reality of objects, properties, relations, and structures. Knowledge is action: at the epistemological level, it plays the very same role that action itself plays at the practical level.

⁵⁶“As for the knowledge to which such an attitude is attributed by the one who learns, this is not quite right. It might seem that knowledge is a measure, and what is knowable is measurable; but in reality it turns out that, although all knowledge concerns what is knowable, not everything knowable is correlated with knowledge – rather, in a sense, knowledge is measured by what is knowable” (Aristotle, *Metaphysics*, Book X, ch. 6).

In physics, epistemology, ontology, and the relation between them are articulated in terms of theory, its application, and the physical object. Theory and its applications are two sides of a single cognitive process. As Bitbol puts it, theory belongs to the “objectified,” representational, logical pole – the ideal pole; the application of the theory belongs to the “pole of pragmatics and practice,” which carries its own appropriate presuppositions. Pragmatic presuppositions underlie the use of language, both everyday and scientific; practical presuppositions are the basis of experimental action, of experience. This is the pole of reality (Crease 2014; Bitbol 2015).

The “gap” between the categories of the ideal and the real, as noted by Jocelyn Benoist in her work on realism (Benoist 2010–2019), is logical: in particular, the gap between theory and its application is logical, not substantial. The ideal (norms, theoretical concepts), nonetheless, is developed in reality; a genuine theory and its concepts are rooted in reality, and nourished by it, in the sense that they satisfy the conditions of appropriateness (conformity to their domain of application) and adequacy (the incorporation of real things and experiences in the use of the theory and its concepts).

The logical gap thus identified is, accordingly, closed logically: theories and concepts are designed to capture reality, the real things themselves; otherwise they turn out to be pseudo-theories and pseudo-concepts. The language games of their use, within the framework of the “forms of life” of physical theories and related practices, represent just such acts of capture. The pseudo-problem of “applying” theory or concepts to reality arises only when the logical gap between them is hypostatized – treated as a gap of substance. The problem of the “gap,” properly understood, is simply the Wittgensteinian problem of rule-following.

Our position is realist, but not metaphysical – and not anti-metaphysical either, since we accept the possibility of knowing things themselves. Traditional metaphysics, which posits norms for special realities and thereby decontextualizes them and their application, is rejected. The non-metaphysical approach is contextual (Benoist 2017, *L’adresse du réel*; Pris 2008; 2012, 2014, “Physics and Metaphysics”; 2014a, 2018).

Norms are used in context to measure the reality in which they are rooted. Such applications are the essence of Plato’s “phenomenon” (Benoist 2016, *Logique du phénomène*). In Wittgensteinian terms, norms are the rules governing language games within a form of life – which is why we consider language games to be Plato’s phenomena, dressed in Wittgenstein’s clothing. The logical gap between the rule and the language game is closed from the outset, in the sense that any rule presupposes the

existence of paradigmatic cases of its application, in relation to which the question of correctness simply does not arise.

This is our Wittgensteinian position. It coincides with Jocelyn Benoist's own contextual position, expressed in slightly different words (Benoist 2017: 99):

L'écart entre le factuel – le réel: ce qui n'est jamais que ce qu'il est – et la norme qui a vocation à le cerner, de façon correcte ou incorrecte, me paraît constituer une structure fondamentale de ce que j'appelle (...) 'réalisme'. (The gap between the factual and the real – that which is never anything but what it is – and the norm whose purpose is to grasp it, correctly or incorrectly, seems to me to constitute a fundamental structure of what I call (...) "realism.")

The initial absence of any gap between subject and object means that these concepts are secondary. Reality as such is not a predetermined metaphysical reality of objects, their properties, the relations among them, or structures. The metaphysical picture of reality has a certain meaning, but it is secondary, and must be correctly understood.

The starting point can only be this: reality is what it is. As such it has no predetermined structure or properties; as such it has no conceptual component. That is, the conceptual simply does not apply to the definition of reality. Conceptualized reality is secondary.

Generally speaking, physical theory does not apply to predetermined physical objects – the concept of an object implies determinacy, identity, repeatability, reproducibility – but to reality itself. The theory “measures” reality; it identifies real things – the very things that, as a result of identification, become real objects in the broad sense. We call “real object,” in the broad sense, anything that has an identity – not only the visible, material bodies of classical mechanics, or the objects of our environment.

Prior to its identification, a real object was not yet an object: it was a fact, an element of reality, but had no identity, no conceptual component, and could accordingly not be compared with other objects, nor ascribed determinate properties; such an “object” could equally well have acquired a different identity.

In other words, a real object is identified only in the context of the application of a theory. It is a contextual object; it does not exist by itself, as some determinate object, in decontextualized, absolutized form.

At the same time, as a result of its systematic identification and the formation of a well-established, reproducible context, a contextual object can come to seem like a metaphysical, decontextualized object, one that can be mechanically referred to. This is how this or that physical “form of life” comes to be formed – the well-established domain of application of a physical theory. The presence of such a domain does not exclude the possibility of a new, unforeseen application of the theory. A form of life is a conceptualized region of reality; it seems to be immersed within reality as such, which can be pictured as a dispositional background.⁵⁷

We see, then, that taking pragmatic and practical measurement into account allows us to establish a connection between epistemology and ontology, which turns out to be contextual. At the same time, it allows us to develop a critique of the notion of the object – to understand what happens at the border between the conceptual and the real. This border is mobile: the conceptual can become real, and vice versa – the real can acquire the status of a norm.

In classical mechanics an object is individualized (one might say visually) by its position in space and time; its state is fixed by its spatial position and momentum. It is an “object” in a broader sense as well: in theory, a mechanical object is a set of points in coordinate space, and its state a set of points in phase space – these are ideal (abstract) objects.

A real mechanical object can have different properties. “Material point,” “perfectly rigid body,” “perfectly elastic body” are concepts, ideal objects; but they can be applied to real situations. Within the context of a real object, that object can accordingly be considered, and thereby become, a real material point, a real perfectly rigid body, a real perfectly elastic body, and so on.

These ideal objects must be correctly understood: what is at issue is not a substantial, metaphysical-Platonist ideal, in comparison with which any real body could only

⁵⁷As Michel Bitbol notes, the concept of a “dispositional background” has become increasingly popular in the philosophy of quantum mechanics (Bitbol 2015: 159–160, 168). For an analysis of the “potential” or “possible” properties of quantum systems, see Sudbery 2016.

It should also be noted that, according to Heisenberg, the “non-actualized” physical properties of quantum systems are “midway between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and actuality” (Heisenberg 1958: 42; quoted in de Ronde 2018b). Indeed, as de Ronde and Massri rightly point out, probabilistic (and hence, in a sense, misleading) predictions are likewise relevant to elements of reality (de Ronde 2018b).

ever be an approximation – what is at issue is the norm. We might equally say that what is at issue are the concepts “material point,” “(perfectly) rigid body,” and so on. A concept (norm), by definition, admits of both precise and approximate applications. In this sense a real mechanical body, depending on context, can be treated as a material point, a perfectly rigid body, a deformable body. The problem of the unattainability of the ideal disappears. This is what Benoist writes (Benoist 2018: 20, *Réalismes anciens et nouveaux*): “(…) un réalisme non plus de l’idéauté, mais de la règle, qui traite les instances réelles non plus comme des approximations de quoi que ce soit, mais comme des applications, correctes ou incorrectes, de la règle” – “a realism no longer of ideality but of the rule, one that treats real instances not as approximations of anything, but as applications, correct or incorrect, of the rule.”

A distinctive feature of classical mechanics is that, in principle, the state of a system can be measured without perturbing the system itself. It can therefore be considered simultaneously from different points of view, in different reference frames.⁵⁸ It can accordingly seem as though the state were simply predetermined – mathematical formalism seems to literally reflect an external mechanical reality, and the difference between reality and theory becomes invisible. But the difference is still there.

Moreover – let us stress this once more – theory and reality belong to different categories: theory belongs to the category of the ideal, not the real. In fact, a predetermined mechanical reality is a reality already formed – identified and established – through theory and experience. Unlike quantum mechanics, classical mechanics allows such a deterministic, predetermined reality to be formed.

Quantum theory, by contrast, allows only a predetermined *probabilistic* reality to be formed as a result of the “interaction” of theory and experience: within this reality, only the probability of a given event’s being registered is predetermined; there is no point in speaking of a reliable prediction of the physical measurement of an event – as a result of measurement, the state of the quantum system changes stochastically.

Quantum objects, generally speaking, are not visualizable: they are objects in a broader sense. The wave function, at a given time, individualizes a quantum object – the state of the quantum system at that time. It should not be forgotten, however, that the wave function, and hence the state of the quantum system, is determinate only relative to some observer – or, as we would say, within the context of observation.

We hold, then, that the philosophy of physics should distinguish between ideal

⁵⁸In quantum mechanics, by contrast, choosing one point of view excludes choosing another.

objects and real objects. The first are, essentially, concepts – rules (norms) of identity, identification of elements of reality; the second are real objects. Any rule (concept, norm) can be regarded as a rule of identity – a criterion of “sameness.”⁵⁹ We are *given* this or that real object when, and only when, we possess a rule for its identification – the corresponding concept; and we are *given* a real object when, and only when, we apply that rule correctly. A rule (norm) presupposes a “form of life” in the sense of the later Wittgenstein’s philosophy: it makes sense to speak of objects and of true statements only within a form of life. The nature of a real object is determined by the nature of the corresponding form of life, and its norms – its “grammar.”

Since the conceptual apparatus of quantum mechanics differs from that of classical mechanics, we can say that we are dealing with two distinct physical “forms of life.” In quantum mechanics, for example, the concept of a material body (a material point) possessing determinate positions in space and determinate speeds (momenta) is simply absent. The reason is simple: at the microscopic (quantum) level, reality has a different nature. Quantum particles are *defined* differently from classical particles: they have a probabilistic nature, exhibit both corpuscular and wave-like properties, have no trajectories (more precisely, in the general case it makes no sense to speak of the trajectory of a quantum particle, or even of a determinate quantum particle at all), and cannot be visualized. The states of quantum particles interfere with one another and become entangled, forming a single system (this, from the mathematical point of view, is a consequence of the linear structure of Hilbert space), within which quantum correlation manifests itself, seen from the classical standpoint as action at a distance. We can nonetheless still say that the electron has position and momentum, but these positions and momenta are physically interpreted by means of noncommuting operators, acting on the Hilbert space of wave functions that describe the electron’s state.

For this reason, the reduction of quantum physics to classical physics is impossible. A partial reduction is possible, in this or that context and in this or that sense; such a partial reduction is a manifestation of the principle of correspondence, which can be understood, in a broad sense, as a principle of the unity of physics, compatible with physical pluralism and with the existence of ontological, epistemological, and conceptual “breaks” within the physical world (Pris 2012).

⁵⁹The relevant concepts are diverse. The correct application of the concept of “view,” for instance, allows us to identify the view, or the real object of the given view, but does not allow us to assert that it is the *same* specific object as the identification of some earlier view. Singular concepts, by contrast, do allow this: your own name, for example, is a singular concept.

The distinction introduced above, between ideal and real objects, allows us to extend the concept of object while keeping it within the bounds appropriate to quantum mechanics. The quantum state (quantum system), as noted, can be considered, in a broad sense, within the context of observation: this object is defined within the context of its preparation – that is, within the context of measurement.

The wave function “describes,” identifies, the state of the quantum system. This state is not a visualizable, classical object with predetermined classical properties; it does, however, have predetermined probabilistic, dispositional properties. In quantum mechanics what is given are potentials, not the position of the system in phase space (coordinates and velocities). When a physical quantity is measured, there is some determinate probability of obtaining a given value; the set of such probabilities depends on the choice of physical quantity. Mathematically, this ontology of potentials is described by a vector – more precisely, a ray – in the Hilbert space of the quantum system (the vectors of a Hilbert space cannot, of course, be visualized in the ordinary sense).

In particular, as is well known, Heisenberg’s uncertainty relation – which points to the impossibility of simultaneously and precisely measuring the position and momentum of a quantum particle – is not an epistemic ratio, as though it made sense to speak of such a simultaneous measurement, only one that would be unfeasible in practice. In fact, a precise simultaneous measurement of the position and momentum of a quantum particle simply makes no sense: as the mathematics shows, the quantity is not even well defined.

In terms of a quantum object, or phenomenon – the object being identified within a phenomenon – it becomes possible to interpret, for example, quantum correlation. It has no deeper nature than what is revealed by the application of quantum theory to describe it. At the same time, it cannot be said to have no nature at all: its nature is determined by quantum theory – no less, but also no more.

The cause of quantum correlations is an entangled wave function. Correlated quantum events are not autonomous, but are defined within the context of their observation; independently of the means of their identification, there simply are no events. The reduction of the wave function in the “process of measurement” is not a real physical process that needs explaining, but a transition into the context of measuring a determinate value of a physical quantity. Accordingly, measurement is not a physical interaction leading to a change in the state of the system, but the identification of a contextual physical reality.

The concept of quantum reality as a reality of potentials – reality as a dispositional background – has Aristotelian roots; it was approached, for example, by Werner Heisenberg. The transformation of this kind of reality cannot be understood on the model of the transformation of a classical, material (in the broad sense) substance. This becomes apparent when we consider the measurement problem in quantum mechanics. The reduction of the wave function, as a result of the measurement of quantum physical quantities, is not described by the Schrödinger equation; the latter describes only the evolution of the dispositional background up to the act of measurement. Attempts to modify the formalism of quantum mechanics so as to explain the reduction of the wave function – that is, the transformation of the dispositional background as a physical process – whether by introducing the consciousness of the observer into the picture or otherwise, have proven unsatisfactory.

In fact, the problem of the reduction of the quantum state is a pseudo-problem. Just as, according to Gödel, the axiomatization of mathematics cannot be complete – there are always true statements that cannot be formally deduced – so too, in the philosophy of consciousness, there is an “explanatory gap” between phenomenal consciousness and, say, its neural correlates; and, in quantum mechanics, the measurement problem requires, for its “solution,” that we take into account the pragmatics and practices involved in the use of theory. To modify physical theory so that it could describe experience itself – the concrete result of a measurement, arising from experience – is impossible, because theory belongs to a different category altogether. Applying a theory to reality requires the involvement of real (non-formalized) experience. In the end it makes no sense to try to formalize the act itself, the “process” of applying the theory. That is why it can be argued that, in point of content, the measurement problem is a pseudo-problem.

The problem of applying quantum theory and quantum concepts to reality – that is, the quantum measurement problem – is an instantiation of the Wittgensteinian problem of rule-following: the problem of the “gap” between a rule and its application (Pris 2008, 2014b). The role of the Wittgensteinian rule, which “measures” physical reality within the language game of its application, is played by quantum theory.⁶⁰

⁶⁰Giovanni Mion quotes Goethe: “The greatest art in theoretical and practical life consists in transforming a problem into a postulate; that is how one succeeds.” According to Mion, this is what Einstein did in creating special relativity, and what Wittgenstein did in resolving the problem of scepticism. We would argue that the same holds for the problems of quantum mechanics. Bitbol writes that the riddles and paradoxes of quantum mechanics, rather than remaining insuperable obstacles, were implicitly transformed into norms, and thereby became the source of a new physics (Bitbol 2019: 220).

This is an interpretation of the Copenhagen interpretation from within the framework of contextual realism.

Quantum theory is “real” in this sense, and only in this sense: it is not a pseudo-theory, that is, it represents a genuine theoretical intention, and has a real domain of applicability. The very existence of a theory as a rule presupposes the existence of well-established language games in which it is applied, within which the “gap” spoken of above is closed by definition. The correctness of any new application of the theory calls for its own justification and substantiation.

The measurement problem, or the problem of applying quantum theory to reality, is the result of mixing the categories of the ideal, to which theory belongs, and the real, to which its application belongs. It is logical in nature, and is dissolved logically.

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Abstract

Contextual Realism and Quantum Mechanics

Igor Pris

The cause of quantum correlations is an entangled wave function. Correlated quantum events are not autonomous, but are defined within the context of their observation; independently of the means of their identification, there are no events. The reduction of the wave function in the “process” of measurement is not a real physical process that needs to be explained, but a transition into the context of measuring a determinate value of a physical quantity. Accordingly, measurement is not a physical interaction leading to a change in the state of the system, but the identification of a contextual physical reality.

The measurement problem, or the problem of applying quantum theory to reality, results from mixing the categories of the ideal, to which theory belongs, and the real, to which its application belongs. It is dissolved logically: the problem is an instantiation of the Wittgensteinian problem of rule-following. The role of the Wittgensteinian rule (norm), “measuring” physical reality within the language game of its application, is played by quantum theory.